MECHANICAL ENGINEERING

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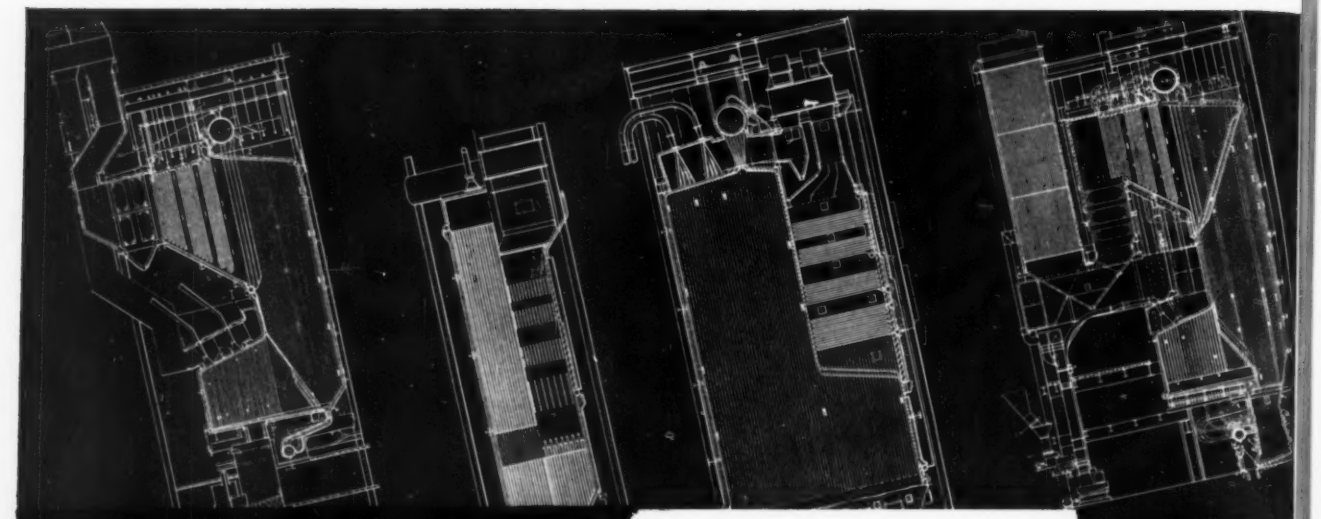

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MECHANICAL ENGINEERING

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Starting a Cornish Engine at the Kew Pumping Station of the Metropolitan Water Board, London

(*See pages 365–369.* *The operator, F. Harvey, comes from Cornwall.*)

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GEORGE A. STETSON, *Editor*

An Appeal

THE article in this issue by James T. Kemp serves a dual purpose. It affords an opportunity to present a series of photographs showing details of some famous Cornish pumping engines that were in active service at the Kew Pumping Station, Metropolitan Water Board, London, until a year ago, and to describe the cycle of operation. It also explains the purposes of the Cornish Engines Preservation Society and presents an appeal for its support. It is hoped that engineers who have an interest in the background of mechanical engineering and particularly in the history of the steam engine, will respond generously to Mr. Kemp's appeal and thus assist in the preservation of some of the giant engines that played such important roles in the development of steam power. A recent letter from Dr. H. W. Dickinson, honorary secretary of the Newcomen Society, vice-chairman of the Cornish Engines Preservation Society, and biographer of James Watt and Richard Trevithick, reports that contributions upward of £1300 have been received to date in England.

The present generation of engineers can never forget the debt they, and indeed modern society itself, owe to the steam engine, or how intimately the steam engine has been associated with the development of the mining industry. For it was in the unwatering of mines in Great Britain that steam power was first applied, and it was in repairing a model of a Newcomen atmospheric engine that James Watt was led to the discovery of the independent condenser and to the improvements that made the steam engine available for driving machinery other than pumps. With little scientific knowledge but a tremendous amount of mechanical skill and ingenuity, the mechanics of those early days utilized the energy in the expansive force of steam to pump water, drive machinery, transport goods on rails, hoist loads, and propel ships through the water. Because of the steam engine, handicrafts gradually gave place to machine production and the western nations developed a high level of living standards under an industrial economy. Although today, aided by pure and applied science, sources of power have been multiplied and diversified to the extent that the steam engine is losing its early importance, steam power still retains its eminence, and the giant engines of former days remain as memorials of a significant and historic past. Preservation of some of these engines will serve as a reminder to future generations of their debt to the past and of the long hard road over which progress in engineering has traveled. May the response to Mr. Kemp's appeal be generous.

Reader Opinion

THE reader-interest poll which is being conducted by the editors of MECHANICAL ENGINEERING is bringing in some interesting comments. This poll, which is conducted by sending to every tenth name in the A.S.M.E. Membership List a letter and reply card, is in its early stages. It will be carried on for a year, and to date results have been analyzed covering the first two months. Although it is too early to get more than a partial picture of reader opinion, certain trends can be noted and are offered as a progress report. The purpose in making such a report during the early stages of the poll is to stimulate interest in it, to urge readers who may receive cards during the remainder of the year to fill out and return them, and to invite other readers to send in comments. Some readers may not agree with the comments so far received and may wish to register their opposition; others may agree and be able to offer helpful suggestions to correct faults.

Much as favorable opinions are valued, constructive criticism is what the editors find most helpful. But as comments are more likely to be general than specific, interpretation of them is not always easy. An attempt at such an interpretation is being made and the status to date is here reported.

Comments can be divided roughly into two general categories—those relating to appearance and editorial technique and those which deal with subject matter and its treatment.

In the first category one finds justifiable complaints about paper and appearance. There is little hope because of the paper shortage and high prices, that better paper can be provided for some time to come. The Publications Committee has committed itself to better paper just as soon as it is available at a reasonable price. Publication costs have been advancing steadily and the Committee has been loath to adopt any changes which will further increase them.

Objections have been raised by readers to carrying over the tag end of an article to fill an available space on some later page. No one objects to this practice more than the editors, but the alternatives are wasteful and leave little choice. Some readers have asked for synopses of articles as an aid to the busy reader. These were dropped several years ago to save space. It would be helpful to know just how valuable readers consider these synopses to be.

A plea for better reporting of Society meetings is being taken very much to heart. More complete reports

will take more space and the suggestion must be balanced against comments to the effect that too much space is already devoted to Society affairs. What the critics want is more emphasis on the contents of technical papers and discussions at Society meetings and less on nontechnical features. An attempt will be made to improve reports to meet this criticism.

Another justifiable criticism is leveled against the length and quality of papers. Here again the editors are in agreement with the critics. With its enlarged editorial staff the Society is in a position to attempt reforms along this line. Progress will depend on the cooperation of authors and program-making groups quite as much as upon editorial talent and time. A magazine is published for the benefit of readers and not for the satisfaction of authors and editors. It would be hard to deny that the reader's best interest is served by brevity and high quality of subject matter and treatment.

In the category of comments on subject matter the most frequent criticism of articles in MECHANICAL ENGINEERING is that they are too technical. Although this criticism is a generality, the editors understand it to mean that readers prefer a descriptive and interpretative treatment of a subject rather than a mathematical or highly analytical one. If the Society had no Transactions, there would be little validity in the criticism that articles are too technical, but because the Transactions is available for technical articles of permanent reference value, few analytical or technical articles are assigned to MECHANICAL ENGINEERING. Probably one basis for the criticism lies in the fact that readers' interests are extremely varied. A reader may find no difficulty with articles related to his own specialty but consider as highly technical articles dealing with other fields.

In contrast to comments that articles are too technical, replies to the reader-interest poll have contained complaints to the effect that MECHANICAL ENGINEERING carries too many nontechnical articles and requests for more articles of a technical nature. Some readers distinguish between technical and practical articles. There have been requests for articles on such subjects as metalworking, hydraulics, small power plants, technical advances, and design of boiler plants and machinery. One reader asks for general articles on technical subjects written to suggest a variety of applications. Several readers want more articles on economics. Complaints about too much on engineering education and on industrial engineering are counterbalanced by requests for more attention to these subjects. Certain readers want articles on management, industrial relations, and engineering history and biography. One reader has asked for "data sheets."

A most gratifying feature on the replies to the reader-interest poll is the great popularity of the "Briefing the Record" section of MECHANICAL ENGINEERING. Readers like technical information and news of engineering advances in abbreviated form. This preference is further borne out in the many commendations of the "Keep Informed" section of the advertising pages. Several readers have given first preference to the advertisements themselves.

To date, one gets the impression that readers prefer technical articles that are brief and of practical rather than mathematical nature, and articles relating to economics, education, and managerial problems. News of Society activities, with the exception, possibly, of broad significant questions of professional status and organization, represent a secondary interest. The reader rightfully prefers articles that help him in the performance of his job but he has a lively interest in matters relating to the advancement of his profession and its services to society.

Machine Design Division

WITHIN the last few months the A.S.M.E. Machine Design Group, which was organized in 1945, has applied for and has been granted the status of a professional division. At recent Society meetings sessions on machine design have produced some useful papers and have been well attended. It was on the success of these sessions that the group was advanced to the status of a division.

Design is one of the important fields of mechanical engineering. It is an essential element in the interests of practically every A.S.M.E. division. It was natural therefore that the question should be raised as to why a separate division of machine design should be necessary. The newly formed division does not propose to take over the design activities legitimately within the fields of interest of other divisions. Rather will it concern itself with subject matter of primary interest to designers. Under its auspices it will be possible to give attention to matters that are likely to be crowded out of programs of other divisions whose interests include much more than design considerations.

The scope of the Machine Design Division covers, for example, the design of machinery and machine parts, such as cams, gears, bearings, clutches, brakes, mechanisms (mechanical, hydraulic, pneumatic, and electric), chain and belt drives; design data on the use of sand, die, and precision castings, weldments, riveted joints, fasteners, machine controls, servomechanisms, powdered-metal products and other materials; stress analysis for the benefit of the designer; and methods of designing for production, accessibility, serviceability, and modernization, and the elimination of noise and vibration.

It will be noted that this list of topics covers elements common to all design, and that the treatment is from the point of view of the designer. Primary consideration is given to the element and the machine, not to the industry which makes use of the machine.

The Machine Design Division should fill a gap in the treatment of the subject matter of mechanical engineering that has frequently been noted by engineers engaged in this field. An energetic program committee should be able to enrich the literature of mechanical engineering with useful material. Articles contributed by the new division will soon appear in A.S.M.E. Transactions and in this magazine.

Preserving the CORNISH ENGINE

By JAMES T. KEMP

FORMERLY MISSION FOR ECONOMIC AFFAIRS, U. S. EMBASSY, LONDON, ENGLAND.
METALLURGICAL ENGINEER, THE AMERICAN BRASS COMPANY, WATERBURY, CONN. MEMBER A.S.M.E.

THE threat of destruction of a Cornish winding engine that had worked for 90 years at the Levant Mine on the cliffs near Lands End, led to the formation, in 1935, of a committee and the raising of a fund to save the historic engine; it and the engine house were bought and put in good condition. A 99-year ground lease with the Manor of Trewellard on a peppercorn rent has been arranged since. This engine was built by Harvey & Company, at Hayle in 1840. It ceased working in September, 1930.

Since 1935 the committee has been expanded into a society with a council, consisting of the eight original founders and representatives of some sixteen engineering societies. Among them are The Institution of Mechanical Engineers, the Institution of Mining and Metallurgy, and the Newcomen Society for the Study of the History of Engineering and Technology.

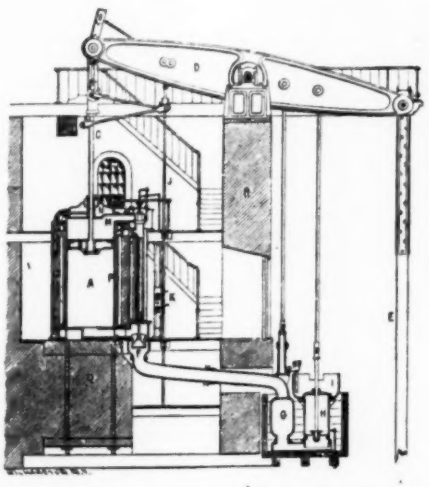


FIG. 1 CORNISH PUMPING ENGINE

(A, steam cylinder; B, piston; C, piston rod; D, beam; E, pump rod; F, exhaust valve; G, condenser; H, air pump; I, hot well; JK, plug rod to actuate valve gear. From "A History of the Growth of the Steam Engine," by R. H. Thurston.)

SOCIETY FORMED TO PRESERVE CORNISH ENGINES

The Cornish Engines Preservation Society has surveyed and listed the engines remaining in the tin and china-clay districts of Cornwall. Their funds have permitted the purchase of the valve gears from the Caudledown engine, 1863, when it was broken up for scrap. By gift they have acquired the 30-in. rotative-beam winding engine at the East Pool Mine near Redruth, the last of its kind to be built in the district (Nicholls, Williams & Company, Tavistock, 1863), and the valve gear from the Goonvean clay-pit engine. The Society has also acquired the Richard Trevithick cottage, the last link left with the great engineer and inventor. The funds have not been adequate to put the cottage in complete repair nor to furnish properly the room to be used as a museum, but the cottage, except for the museum room, is rented to the district visiting nurse to help with the care and maintenance.

It is proposed to acquire four pumping engines in the tin-mining area, four pumps, and two rotative-beam engines in the china-clay area near St. Austell. Each of these engines has some distinctive feature or is the work of one of the famous Cornish engineers. Some engines have worked for long periods. The 80-in. engine at the South Crofty mine, for example, was built in 1854 for Wheal Alfred; it was moved to Crenver and Wheal Abraham, then to Tregurtha Downs; in 1903 it was re-erected at South Crofty where it has been working night and day for 44 years.

This engine has a 10-ft 4-in. stroke. It is pumping 375 gal at 5 double strokes per min from a depth of 2021 ft. It is an impressive experience to watch this giant at work. There are six other engines with 30-in., 50-in., 80-in., and 90-in. cylinders, respectively, still pumping tin mines or clay pits. One single-acting 22-in. × 6-ft-beam winding engine at the Rostowrack clay pits will still work when it is required. It was built about 1850.

The list of engines marked for preservation is a short one when it is recalled that Trevithick in the first 40 years of the last century so greatly improved on the efficiency of the popular Boulton and Watt engines as to blaze the trail for the high economy of steam prime movers of the present century. The fact that a Cornish engine was built for mine pumping as late as 1892, and that two of those now marked for preservation were moved to their present locations as late as 1908 and 1912, respectively, reconditioned and continued at work, is evdence of the sound engineering by the Cornishmen who followed after Trevithick.

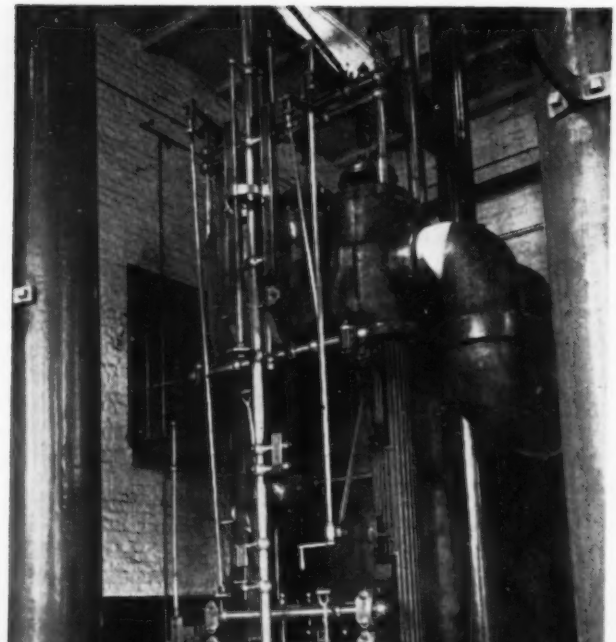
Reports of the exceptional economy attained by Cornish engines, circulating in the decade 1830 to 1840, led to the use of these engines elsewhere for drainage and waterworks. In 1840, Harvey & Company of Hayle signed a contract with the East London Water Works guaranteeing a duty of 90,000 ft-lb per bushel of coal. The company moved a second-hand engine from a mine in East Cornwall and on test obtained a duty of 97,146,268 ft-lb. The Boulton and Watt engine on the same work tested 42,847,598 ft-lb.

Other reports are to be found as, for example, the three engines bought by the Dutch Government in 1840 for drainage of Haarlemm Meer, are said to have consumed $2^1/_2$ lb of coal per hphr, as compared with a general average of 15 lb in Germany, Holland, France, and England. The skeptical engineer of the present day may point out that test methods 100 years ago were neither uniform nor took into account the varying calorific values of the fuel, yet the engines built by two generations of Cornishmen did improve prime-mover economy beyond anything attained up to the middle of the nineteenth century.

Great skill was developed in iron-founding and machining the huge cylinders and the great pistons, rods, and beams. Horizontal tubular boilers were built to work at high pressures.

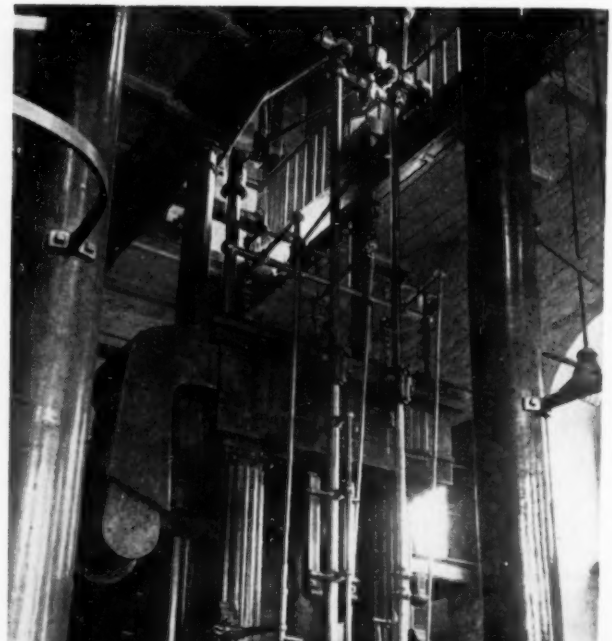
The high economy attained was due also to Trevithick's invention of the Cornish boiler, which made steam available at

The author is indebted to Dr. H. W. Dickinson, honorary secretary of the Newcomen Society and vice-chairman of the Cornish Engines Preservation Society, for permission to use portions of the Society's reports, for valued editorial assistance in preparing this paper, and for the photographic illustrations which were supplied through the courtesy of The Shell Petroleum Co., Ltd., of London, and to the Cornell University Press for permission to reproduce Fig. 1.



VALVE GEAR AND STEAM CYLINDER OF CORNISH ENGINE AT KEW PUMPING STATION, LONDON

[At upper right, steam enters valve chest in which are three valves: (from right to left), governor (throttle) valve, operated by handle in foreground; equilibrium valve, operated from the upper of two horizontal arbors; and steam valve, operated from arbor near top of fluted columns. Expanded steam passes through equilibrium valve and fluted columns into lower portion of cylinder (behind columns) and from cylinder through exhaust valve, on floor between columns, into condenser beneath the floor. Exhaust valve is operated by the lowest of the three arbors. Valve arbors are set by vertical plug rod, connected to beam above, and are operated by gravity by means of rods passing through floor. Tripping mechanism (cataract rod) is at extreme left.]



VALVE GEAR ON COMPANION ENGINE OF SLIGHTLY DIFFERENT DESIGN

[Double plug rod, with portion of parallel motion (at top) which drives it from beam. Governor (throttle) handle at left; cataract rod at right. Note levers with spiral handle ends attached to arbors for starting engine. Steam is admitted above the piston; the working stroke is downward, at the end of which opening of the equilibrium valve equalizes pressure on both sides of piston. The exhaust valve opens when the piston has returned to the top of the stroke. The weight of the pump parts on opposite end of beam lifts the piston to the top of its stroke. Illustrations on page 369 show the weights on the pump end of the beam.]

the high pressures of 40 to 45 psi. Trevithick fireboxes and long flues favored complete combustion. The attention he directed to stoking, to balance and friction, his use of economizers and steam jackets, improvements in valve gears and the high degree of steam expansion that followed his lead, all contributed to the improved economy.

The objectives of the Cornish Engines Preservation Society are moderate indeed, in the light of the great era in engineering development which it hopes to perpetuate in monuments from the very hands of the masters.

OUR DEBT TO THE CORNISHMEN

North America can well share in this task, and by assisting can, in a small way, acknowledge the debt owed by modern engineering to the Cornish mining engineers of a past century. Miners from Cornwall have put their mark on American mining since 1740 at least.

A Cornishman erected the first steam engine on the continent of North America in 1757. The hard-rock miners, who came over in the middle and later 1800's, brought their skills and experience to the coal fields of Pennsylvania, to the copper mines of Lake Superior, and farther west. Their names have been on our mining pay rolls and on our honor rolls for a hundred years. Cornish names dot the maps of American mining regions. Cornish miners were known in American mining camps as "Cousin Jacks." The verse that used to be on the lips of the copper country miners at the turn of the century, tells that story:

"By their names Tre, Pol, and Pen, you can tell the Cornishmen."

The passing of the Cornish engine was marked by a ceremony in London at the final working of the great 100-in. Harvey engine at the Kew Station of the Metropolitan Water Board on May 25, 1946. It was then disconnected, after pumping 8,000,000 gal per day continuously from 1869 to 1942. Thus is history made.

AN APPEAL FOR MEMBERSHIP IN SOCIETY

An appeal is made to American engineers and engineering firms to assist with gifts and membership in the Society. Letters may be sent direct to the Hon. Secretary, Cornish Engines Preservation Society, The Observatory, Falmouth, Cornwall, England.[1]

It may also seem appropriate to the American national engineering societies most closely interested to become sponsors or contributing members of the Cornish Engines Society and so place the mark of American professional approval on this unusual effort to perpetuate the memory of a group of great engineers.

In conclusion it may be remarked that if this program is carried into effect, it will make Cornwall a Mecca for engineers the world over. The Society will welcome them with the hospitality for which the Duchy is renowned.

ILLUSTRATIONS OF CORNISH PUMPING ENGINES

After the foregoing article had been completed and set in type, the author received from Dr. H. W. Dickinson, honorary secretary of the Newcomen Society and vice-chairman of the Cornish Engines Preservation Society, an excellent set of photographs of some of the Cornish engines at the Kew pumping station of the Metropolitan Water Board, London, through the courtesy of The Shell Petroleum Co., Ltd., of London, England.

The Kew pumping engines are of the waterworks type and not of the mine type referred to in the foregoing article, but the Shell photographs illustrate many details that are common to both. So enormous are these pumping engines that a photograph of the entire machine is impossible and the reader is referred to the sketch, Fig. 1, to refresh his memory of the general arrangement of the working parts.

The last picture in the paper shows four of the cast-iron Doric columns with their cast-iron cap which support the bearings of the beam above, which take the place of the masonry pillar that was customary in mine pumping engines. Between the two sets of columns can be seen the top of the steam chest on which the operator is standing. The frontispiece shows an operator in the act of starting one of the engines at the Kew pumping station.

The photographs that accompany the article show various details of two of the Kew pumping engines. In order that the reader may understand the cycle of operations, the following description is quoted from a booklet "Cornish Pumping Engines," published in 1945 by the Cornish Engines Preservation Society.

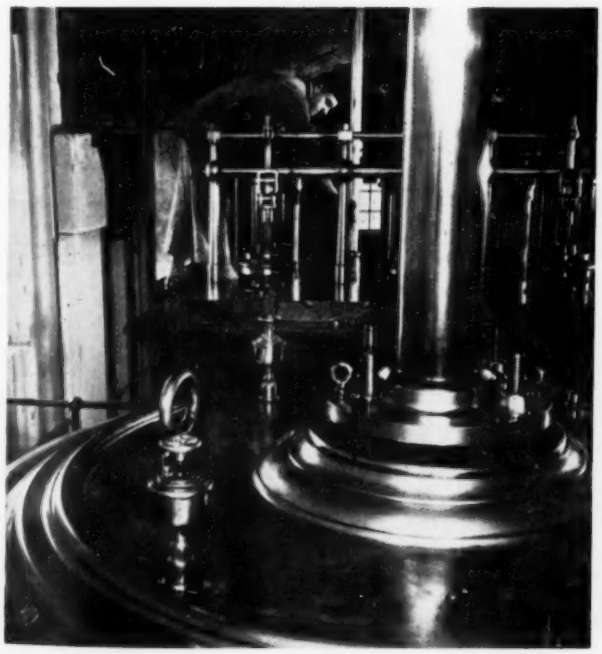
THE CORNISH STEAM CYCLE

"The Cornish pumping engine was the final development by Richard Trevithick and his colleagues of the single-acting beam engine, which was originally introduced by Thomas Newcomen for pumping water from the Cornish mines, and which James Watt so greatly improved. The valve gear has been changed in details only, and remains in work today substantially as Watt modified it 165 years ago from Newcomen's beam- and plug-rod-operated valves of 1712.

"The piston is connected to the indoor end of the beam by the piston-rod and parallel-motion gear. The outdoor end of the beam is attached to the pump rods, or, in the case of rotative-beam engines working on the Cornish cycle, it is connected to a crank by a heavy sweep rod. The inertia of these working parts helps to carry the engine through its cycle.

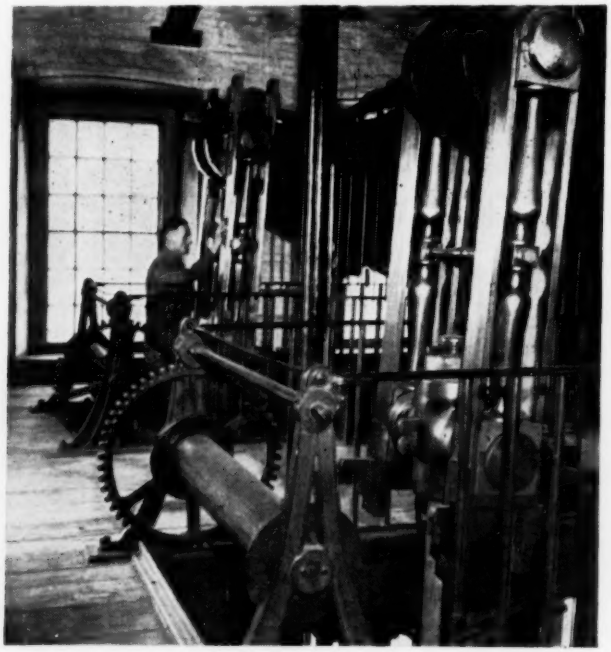
"The cycle is as follows: On the steam valve opening, steam at about 40 lb to 45 lb per square inch pressure enters the top

[1] Gifts may be made also through THE AMERICAN SOCIETY of MECHANICAL ENGINEERS, or the American Institute of Mining and Metallurgical Engineers.



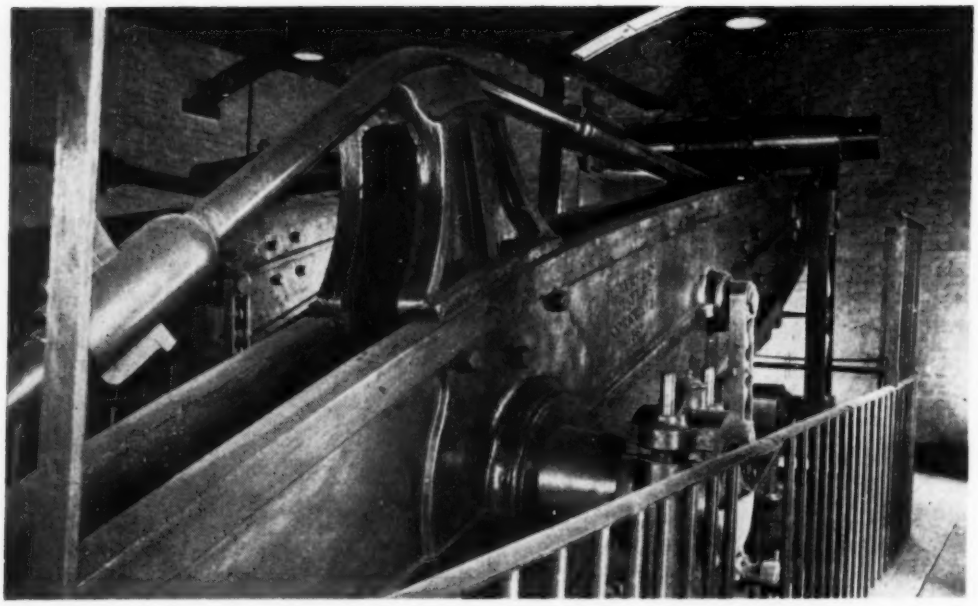
TOP OF STEAM CYLINDER WITH VALVES AND STEAM CHEST IN REAR

(Faintly visible in extreme upper background is a portion of the cast-iron cap which supports the beam above. Two of the valves are seen on the top of the steam chest. The third is behind the vertical piston rod, the upper end of which is connected to the beam above.)



ENDS OF BEAMS OF TWO ENGINES

(Upper end of piston rod is barely visible at lower right. Note portions of straight-line mechanisms which connect piston rod to the beam, and two winches for handling heavy parts. The short turned member takes the compression and the strap the tension stresses.)



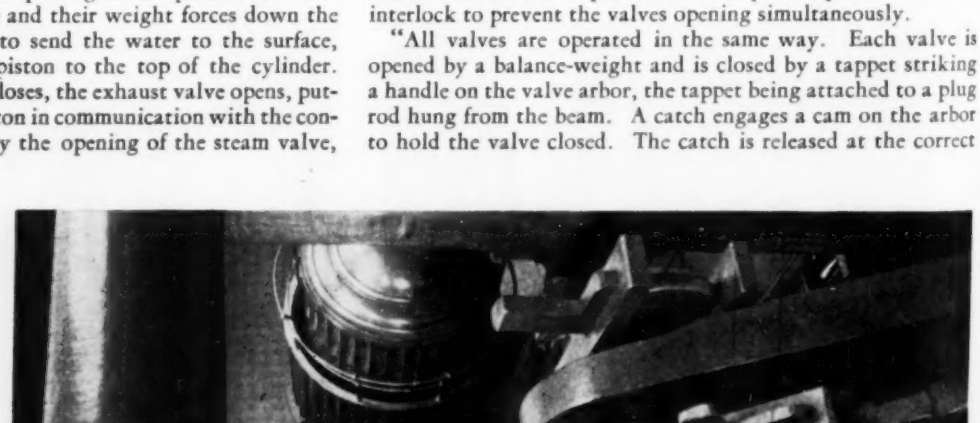
BEAM OF CORNISH ENGINE

(Beam of second engine is in background. Connection to piston rod is at far end of beam. Cast on the beam is the maker's name, Harvey & Co., Hayle, Cornwall, 1862. Note cast-iron structural members supporting roof of building.)

of the cylinder and forces the piston down, so drawing the pump rods up. Any steam below the piston passes to the condenser through the exhaust valve, which is opened slightly before the steam valve. The vacuum below the piston, created by the condenser, assists the steam stroke. The steam valve is closed at a point which may be varied; it is usually about one third of the stroke. The engine then works expansively to the bottom of the stroke, when the exhaust valve closes and another valve opens which allows steam to pass from the top to the underside of the piston, thus placing it in equilibrium. The pump rods now take charge and their weight forces down the plunger poles in the shaft to send the water to the surface, whilst the beam pulls the piston to the top of the cylinder. The equilibrium valve then closes, the exhaust valve opens, putting the underside of the piston in communication with the condenser. This is followed by the opening of the steam valve, when the piston again descends under the pressure from live steam assisted by vacuum beneath the piston, and the cycle is repeated.

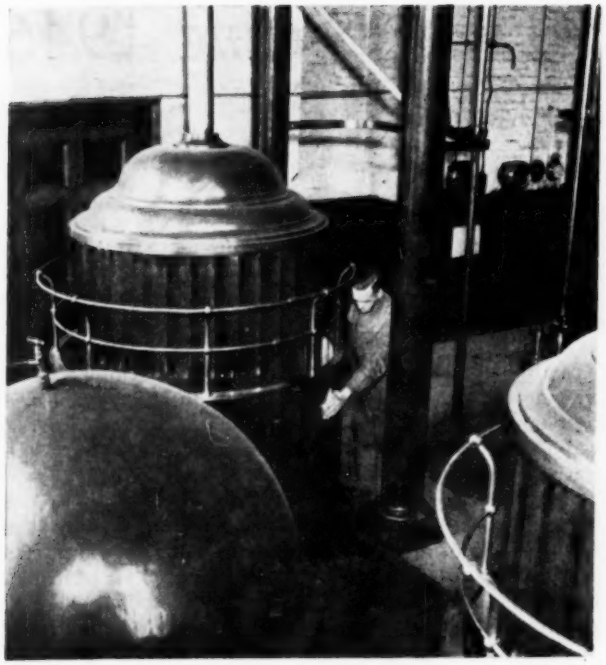
"The engine is provided with four double-beat Cornish valves: the governor, the steam, and the equilibrium in the top valve chest, and the exhaust in the bottom one. Each valve is actuated from a separate arbor, except the governor, which is merely a throttle valve under the control of the driver. The upper arbor actuates the steam valve, the middle one the equilibrium, and the lower arbor the exhaust. The equilibrium and exhaust arbors are provided with a pair of quadrants which interlock to prevent the valves opening simultaneously.

"All valves are operated in the same way. Each valve is opened by a balance-weight and is closed by a tappet striking a handle on the valve arbor, the tappet being attached to a plug rod hung from the beam. A catch engages a cam on the arbor to hold the valve closed. The catch is released at the correct



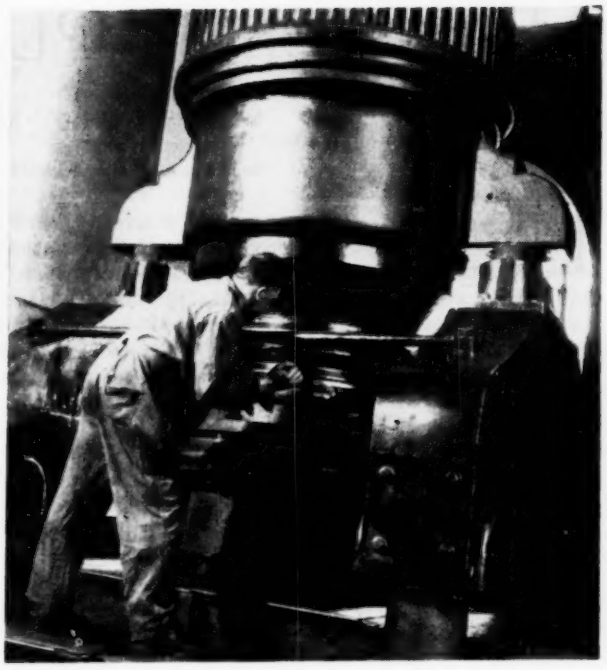
PUMP END OF BEAM LOOKING DOWN

(End of beam of one engine and lower ends of pump rods of two engines are shown. The fluted mass at the bottom of the rod is a weight, balance box, which lifts the piston at opposite end of beam and pushes the plunger into the pump chamber below the floor.)



UPPER END OF PUMP ROD

(Parts of two pumps are shown at operating floor level. The fluted cylinders are the weights, balance boxes, that actuate the pump plunger by gravity. In left foreground is the top of an air chamber to equalize pulsations of flow from the pumps.)



PUMP PLUNGER

(The lower end of the fluted weight, balance box, on the pump rod is seen. Below it the pump plunger passes through the gland, which the operator is tightening, into the pump below.)

point of the stroke by the movement of a cataract rod. The "cataract" which moves the rod consists of a water dashpot with a controllable vent.

"The delay in valve opening imposed by the cataract causes a pause at the end of the stroke. With two cataracts there is a pause at each end of the stroke. If one cataract is used the engine pauses at the end of its equilibrium stroke only. Pauses have the advantage of giving the pumps time to fill and of allowing the pump valves to settle in their seats without shock.

"In starting the engine the equilibrium and exhaust handles are worked by hand.

"In Cornwall the equilibrium handle is known as the top handle and the exhaust as the bottom handle. The steam handle is known as the horn, due to its shape. The steam tappet is known as the slide and the equilibrium and exhaust tappets as the clamps and the valve-retaining catch as the scoggan catch; the cam being known as the scoggan; the top and bottom valve chests as the top and bottom nozzles. The communication between the top and bottom nozzles is known as the perpendicular pipe. The beam is known as the bob; the connecting-rod of a rotative engine as the sweep rod. A beam winding engine is called a whim. And, to end this short glossary, the equilibrium valve is referred to by the Cornish engine driver as the 'Uncle Abr'am valve.'"

VICTORIAN MACHINE DESIGN

ADVANCES *in* PLASTICS *During* 1946

By HENRY M. RICHARDSON

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THE principal features of the plastics industry during 1946, were the consolidation of the developments made during the war years and their adaptation to peacetime uses. While capacity for the production of plastics had greatly increased during the war, there was continual shortage of all plastics relative to the demand for them. Nevertheless, very large quantities of vinyl-resin sheet, film, and coated fabrics were produced and distributed in the consumer market. Likewise, injection-molded plastics, distributed as consumers goods of all sorts, were in greater demand than ever before. The most significant change in this respect was the increased availability of polystyrene which appropriated many applications which had been previously molded of the cellulosics or the ureas.

Far more plastics would have been produced except for shortages of raw materials resulting from curtailment of production in the coal and steel industries which resulted in shortages of benzol, phenol, naphthalene, and by strikes in the chemical industry, further reducing the supply of phenol, plasticizers, formaldehyde, and synthetic resins and compounds. There is in process an expansion of the capacity to produce synthetic resins which should double the 1945 output and be $3^1/_2$ times the 1941 output and almost 7 times 1939 (1, 2).[1] It is expected that supply and demand may come into balance sometime during 1947, provided we have a free economy and are not beset by industrial stoppages.

Technical advances consisted mainly in the public disclosure of new materials and processes which had been held secret during the war, and a further advancement of those techniques which had been developed for the production of articles for military requirements.

Probably the greatest advances in materials were made in the field of thermoplastic vinyl polymers. We are all familiar with the development of flexible sheet, film, foil, and coated fabric, based on polymers and copolymers of vinyl chloride. While most of the vinyl resins were produced for the usual processes of compounding, extruding, and calendering, there were other forms of resin polymers appearing as latex (3) suspension in water, as pastes or "plastisols," where the resin is suspended in plasticizer in the form of a paste, or "organosols" (4), where the resin is suspended in a mixture of plasticizer and volatile nonsolvent thinner or diluent. All three of these fluid types are used for the formation of sheet, film, or surface coats without the use of the ordinary extrusion and calendering equipment. This increases the versatility of these resins and adapts them to use in the leather and textile industries without the necessity for setting up the usual compounding and processing equipment characteristic of the rubber and plastics industries.

While polystyrene became available in much larger quantity, no outstanding technical improvements were noted, although the industry made progress in its technique of control, compounding, and fabrication. A very useful copolymer of styrene was brought out, called "Plexene M" (5), which has the water resistance of polystyrene and is superior in its strength, toughness, solvent resistance, and resistance to weathering. It is of particular interest, since its mechanical characteristics and its stability recommend it for many applications which heretofore could only be fulfilled by the thermosetting materials.

Methyl methacrylate, used for transparent enclosures on aircraft during the war, was found to be in larger demand for civilian uses, both as fabricated from sheet and as molded, than had been expected. Shortages of raw material prevented satisfaction of the current demands.

Polyethylene (6, 7) was developed during the war as a tough, flexible, low-loss insulation for coaxial cable used in high-frequency electronics. The peacetime demand is for extruded film and foil, and molded articles which make use of its flexibility, toughness, lightness, and moisture resistance. Since polyethylene is based on very abundant raw materials, it can be expected that its uses will greatly increase.

A close relative of polyethylene, polyfluoroethylene (8), was announced under the name of "Teflon." It is an extremely stable compound, unaffected by acids, alkalies, solvents, water, or temperatures up to 300 C. It has electrical properties similar to polyethylene but it is rather difficult to mold, owing to its very high softening or sintering temperature which approaches its depolymerization temperature.

In the field of polyamids, some new forms of nylon became available in limited quantities. Most interesting of these are the leatherlike flexible sheets or molded products, and the thin film or foil.

In the field of polyesters, there was further development of resinous plasticizers and of unsaturated alkyd resins to be used in combination with a vinyl monomer (usually styrene) for the production of low-pressure laminates (9).

In the field of cellulosic plastics, the use of gel lacquers (10) from cellulose acetate butyrate was disclosed. Also cellulose propionate was produced in substantial quantities.

In the field of thermosetting condensation resins, the melamines, ureas, and phenolics, there were changes in formulation brought about by the shortage of certain raw materials. For example, in the resins used for laminated products, there was a trend toward a higher utilization of phenol and a relative reduction in the consumption of cresols and cresylic acid.

The vulcanizable elastomers are considered as rubber rather than as plastics. Nevertheless, significant developments during the year included combinations of synthetic rubber with various plastics (11, 12, 13, 14), such as, combinations of Buna N, synthetic rubber with vinyl-chloride polymers and with phenolic resins, providing material with unique and valuable characteristics.

The silicone resins underwent considerable development and study and are beginning to find commercial applications not only as electrical insulating materials (15) and bonding agents but also as lubricants (16) and elastomers (17, 18).

Additional work on materials is reported including starch ethers (19), improved ion-exchange resins (20), new furane resins (21), some work on protein resins (22, 23, 24), discussion of plastic properties as a function of molecular structure (25), reports of resistance of plastics to bacteria, fungi, insects, etc. (26, 27).

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

Contributed by the Rubber & Plastics Division and presented at the Annual Meeting, New York, N. Y., December 2–6, 1946, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

APPLICATIONS FOR PLASTICS

Following the availability of larger quantities of vinyl resins has been a rapid advance in the use of vinyl-resin films, both supported and unsupported, in the field of textiles, leather, and paper, for use as protective apparel (28), upholstery (29, 30, 31), draperies, packaging (32, 33, 34, 35, 36, 37, 38, 39, 40), wallpaper (41), floor coverings (42), spray coatings (43, 44), yarn, and cordage (45).

The vinyl resins, the polyamids and the cellulosics were fabricated by extrusion (46, 47) for many useful purposes as vinyl insulation on wire (48), saran and nylon monofilaments (49), and extruded thin sheet (50).

As usual, one of the principal uses for synthetic resins was in protective coats (51, 52). The alkyd resins (53) predominate in this field, principally for paints and enamels for metal and wood (54). There was also some discussion on protective coatings based upon vinyl resins (55, 56), the field of printing inks (57), and the use of hot-melt protective coats in the packaging of metal parts (58).

In the field of adhesives, no startling new things were presented although reports on earlier developments were published covering adhesives for paper (59), wood and metal (60), and the general field of resin-bonded plywood (61, 62, 63, 64)

Laminated products (65) were re-establishing themselves in the usual peacetime outlets of the electrical, furniture, and architectural fields. In addition, there was published some work on the improvements of textiles (66) for use in laminated plastics, and on glass-cloth laminates (67), bonded with melamine (68) or silicone (69) resins. Nonwoven cotton webs (70) for laminates received some attention.

Following the development of the uses of unsaturated polyester copolymers for low-pressure laminating and the low-density sandwich construction, developed during the war for radome and aircraft component structures, was a series of articles on honeycomb (71, 72), foam (73, 74), corrugations (75) and other means of reducing density; as well as reviews of the general method (76), discussions of techniques (77), and specific applications (78). The postforming of laminates (79), which found many applications during the war, was summarized in one article.

In the molding of thermoplastics, there were interesting articles on methods of molding unplasticized vinyl resins (80), the injection of nylon (81), the production of lenses (82) from transparent thermoplastics, and some interesting articles on molded components for piano actions (83, 84).

Miscellaneous applications included the use of plastics, both molded and laminated, in lighting fixtures (85), the use of rubber and plastics in chemical construction (86), and a light fly rod (87) of resin-bonded glass fiber. Testing of molded plastics (88) for impact strength (89), flow and cure (90), and effect of temperature and humidity on cellulosics (91) had some attention.

EQUIPMENT AND ENGINEERING

One of the most notable advances in the industry was the broad and general adoption of high-speed transfer molding of thermosetting materials with the aid of high-frequency electronic preheating. There was considerable development published relating to transfer-molding equipment (92) and mold design (93 94). Likewise, there were reviews of injection (95) and compression (96) mold design, discussion of tolerances (97, 98), and the pressure requirements of molding (99) as a function of temperature and type of thermosetting compound.

There were articles on heating operation (100), heating equipment (101, 102), and on hard-chromium plating (103), for molds. Also considered were evaporative metal coatings (104), for plastics, and some interesting articles on design of plastic parts (105, 106).

Fabrication of sheet and film received considerable attention during the year (107), including new methods and equipment for electronic heat sealing (108), as well as the older processes of cementing (109, 110).

The annealing of polystyrene (111) and its fabrication by machining (112) were discussed.

Cast plastics and casting processes (113) received some attention as well as the sealing of metal castings (114), and the impregnation of plaster with synthetic resins (115).

The major reference publications of 1946 included, as usual, Modern Plastics Encyclopedia; The Directory of Materials, Products, and Services (116). Dr. Kline's series of articles on the German plastics industry appeared regularly; "German Plastics Practice," by DeBell, Goggin, and Gloor (117). "Plastics Mold Engineering," by DuBois and Pribble (118), and the series of Design Standards for Plastics by The Society of the Plastics Industry, including "Metal Inserts," "Tolerances," "Testing," "Cementing and Assembly."

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ADVANCES *in* RUBBER *During* 1946

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GOVERNMENT release of natural rubber for tire manufacturing was the single most important event to the industry during 1946. On the popular small sizes of passenger-car tires, only 1¼ per cent of natural rubber was allowed in January, 1946. By November 1 this percentage was increased to 23 per cent, and for small truck sizes the amount of natural rubber has since been boosted to 67 per cent. For truck and bus tires, as well as for airplane tires, 100 per cent natural rubber is now permitted by the Government.

TIRE PRODUCTION MOVES AHEAD

In addition to these partial reconversions to natural rubber in tires, a few statistical facts illustrating the tempo of the past year's tire production should prove of interest. In 1940, just prior to the war, passenger-car tire production in the United States averaged 4,000,000 per month; for 1946 the monthly rate unfolds a 50 per cent increase to almost 6,000,000 tires per month. For truck tires the 30-day output rate in 1940 was 725,000 units; in 1946 it averaged approximately 1,400,000 per month, representing an increase of approximately 100 per cent(1).[2] Many refinements in tire-building machinery and automatic and semiautomatic equipment have helped to accomplish this amazing production record (2, 3).

It is claimed that the tires being produced now, with the increased percentages of natural rubber and the improved synthetics, along with numerous other advancements, are superior to prewar natural-rubber tires (4). The improvements, other than the modified elastomers, contributing to the over-all outstanding performance of current-day tires, result from such as the following:

(*a*) New and modified forms of carbon black, so essential for reinforcing the GR-S compounds, give more efficient cooler running carcasses, having greater resistance to tread cracking (5 to 9).

(*b*) New designs for tires bring easier rides, better stability, and greater safety (10 to 12).

(*c*) New tread patterns provide longer wear and better nonskid qualities. New materials for tire cord give stronger casings with better blowout resistance (13 to 16).

Improvement of the adhesion of the tire cord to the tire body is a constant development assignment in all tire plants. Much was reported on this subject during the year that is noteworthy in view of the difficulties previously encountered in obtaining adhesion to synthetic cord (17 to 21).

The tire cords which are the backbone of any tire are now being made of various and improved types of cotton, rayon, nylon, and steel (22).

Steel tire cords in the form of twisted small-diameter steel-wire cables for heavy-duty truck tires are reported to have several times the strength of textile fabric ply, and provide considerably more resistance to bruises and blowouts. These wire cables, in addition, open up a new field for heavy-duty V-belts and power-transmission and conveyer belts (23, 24).

Butyl inner-tube tests, conducted under desert temperature conditions operating at high speed with overloads, 24 hr per day, 5 days per week, proved to be vastly superior to natural-rubber inner tubes in air-holding ability (25, 26).

No summary of advances reported in an industry is complete without reference to the year's "biggest," whatever it may be. One company claims to have built the biggest truck tire in its 48-year history, an earth-moving tire casing, 27.00 × 33 size. It has a load rating of 31,050 lb and in itself weighs 1627 lb (15). The biggest bomber tire in the world was built by another company, measuring 110 in. in over-all diam and 44 in. across beads. This one tire and tube weighs 2600 lb (27).

Rubber as a resilient suspension medium for passenger cars, trucks, buses, airplanes and Pullman trains made the "limelight" during the year. Much more should be heard on this subject within the next 3 to 5 years (28 to 31).

Much could be written for this past year on the development of plastics by the large tire and rubber companies and the integration of the rubber and plastic industries. Finished products fabricated from unadulterated plastics, and plastic and synthetic-rubber compounds of various-percentage combinations, have made their appearance on the market, introduced by several of the large rubber companies. These items range from garden hose to gasoline hose, wire coverings to floor coverings, packaging materials to shoe soles, automobile to airplane parts, shower-bath curtains to milady's plastic patent-leather purses, shoes, and belts, ice buckets to household, hotel, and theater upholstery materials, etc. (32, 33).

Phenolic plastic resins are reported to blend with synthetic rubbers to produce adhesives of outstanding quality (34, 35). It is disclosed also that phenolic-resin-impregnated papers are being used in the rubber industry to take the place of reinforcing steel stampings in automotive mechanical rubber-goods parts.

RESEARCH DEVELOPMENT

"Research on synthetic rubber and latex already has reached the stage where new molecule building is almost a daily occurrence" (36). Notwithstanding, additional research facilities have recently been completed by General Tire and Rubber Company and by du Pont, augmenting Akron's buildings already devoted to this work (Firestone's and Goodyear's ultra-modern research units). In addition, a new structure well under way by the B. F. Goodrich Company is scheduled for completion in 1947. Besides these research centers, a vast number of universities have entered into contracts with the Office of Rubber Reserve (RFC) covering research on synthetic rubber (37). Existing facilities and organizations to date are solely responsible for the high quality and versatility of present-day rubber, both natural and synthetic. However, a tremendous amount of work still remains to be done to perfect, among other needs, better plasticizers, good high-temperature stabilizers, and other materials to extend rubber's usefulness (38).

Rubber research chemists and physicists continue their endeavor today more ardently than ever now that the gap is narrowing between their present-day knowledge of molecular theory of the elastomers, and that of actually being able to see the rubber molecule. A new lens element or pole piece is

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[2] Numbers in parentheses refer to the Bibliography at the end of the paper.

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under development to improve the electron microscope. This may make possible the visual isolation of the individual molecules of synthetic and natural rubbers (39). In the interim of this period of actually separating the molecules, much is being learned of molecular behavior and structure (40).

We should note here that the electron microscope has enabled better evaluation of carbon black (41). Research work, in 1946 on black has aided the rubber industry in processing stocks and producing vulcanizates of more excellent properties (6, 7, 9, 42, 43). Since various blacks influence differently the modulus of compounds, a comprehensive investigation of the surface activity of a number of carbon blacks was undertaken during the year (44). Recent reports have referred to research development of a new white reinforcing material which functions in much the same manner as does present-day carbon black by embellishing the physical properties of a vulcanizate (45).

The infrared method of examination has associated variations in molecular chain structures of elastomers with the physical properties (46). Techniques with infrared spectroscopy result in faster and more accurate solutions of research problems involving molecular structures, particle sizes, polymerization, etc. (47). Particle sizes and molecular weights can also be determined now by a new means of light-scattering measurement (48, 49).

Investigators in some quarters have centered their efforts on the study of vulcanizates under tension. As a result, an apparatus has been invented to measure and correlate the tensile and electrostatic properties of rubber and GR-S at elevated temperatures (50). Tension studies have also advanced the theory of correct dependence of stress upon temperature (51). Tension samples at constant extension have unfolded a molecular theory to describe the permanent set taking place at elevated temperatures (52). Further, under extension, strain studies have been reported on the relation of stress-time and temperature (53). Also, data have been disclosed covering a new approach to the theory of tension-stress relation (54).

On molecular structures of rubberlike elastic bodies, a new theory has been expounded covering the molecular reaction under deforming forces (55). Large elastic deformations, as well as the effect of mechanical deformation on swelling capacity, have been explained in theory by several investigators (56, 57). Also, a new approach to the theory of long-range rubberlike elasticity has been set forth, associating it with an entropy effect dependent upon the possibility of easy rotation about single bands in giant chains of network molecules (58).

Much has been reported on physical chemistry of high-polymeric systems (59 to 88).

X-ray analysis has also continued to improve our knowledge of high-polymeric elastomers. Investigations made on vulcanized and unvulcanized synthetic and natural rubbers, stressed and relaxed at different temperatures, have revealed much about the amorphous and crystalline structures, and molecular orientation (89 to 93).

Research work on vulcanizing agents has unfolded an entirely new class of nonsulphur halogen compounds beneficial to GR-S (94).

Data of far-reaching interest were presented during the year on the coefficient of friction of synthetic tire-tread compounds on ice (95).

Research work on the original government GR-S and on new or modified synthetic rubbers continued throughout the year. To date, over 360 experimental polymers have been approved by the Office of Rubber Reserve and authority granted for trial production of a specified quantity of each for large-scale evaluation of processing and vulcanized properties.

Incidentally, although estimated demand for GR-S for the year was set at 679,000 long tons, it was not believed that production would exceed 615,000 tons due to limited butadiene supply (96). Some interesting figures on the cost of alcohol-butadiene and petroleum-butadiene were published (97). Disposal of synthetic-rubber plants to private manufacturers continued to occupy the attention of government officials (98).

DEVELOPMENTS IN RUBBER

For the past century, the development of synthetic rubber of one sort or another has been worked upon by men of all means (99). The development of synthetic rubber in America extends over a period of almost 40 years (100). The most striking advances were crowded into the last decade and especially during the war years just past. This is evidenced by the amazing volume of literature being released today, now that government restrictions have been lifted from most subjects.

Of the 360 experimental polymers previously mentioned, approximately 80 have been put into worth-while production. These polymers were developed for all kinds of end products. Many of these experimental types were modifications of butadiene-styrene copolymers, resulting from the use of new emulsifiers and coagulants. But others have involved the replacement of either the butadiene with another diene such as isoprene or the replacement of the styrene with either substitute styrenes or other vinyl compounds. Descriptions of many of these appeared in the literature (101 to 104).

One of these modified GR-S copolymers provides extremely good building tack, a property so essential for tire building (105, 171, 172). The incorporation of pigments at a considerably increased rate during milling is also claimed for some of these new copolymers (106). Others have provided the wire-and cable-covering industry with an elastomer of exceeding low water absorption (107).

In extensive production is a whole new set of high-heat-resistant elastomers. Some of these withstand continuous temperatures of 300 F, and endure temperatures of more than 500 F for 8 to 10 hr. They can also be used effectively at temperatures as low as —70 F (108). There will undoubtedly be many uses for these elastomers since they too can be tailor-made (109, 110, 169, 170).

During the period of critical shortages of the war, the rubber industry investigated and tested various high-molecular-weight polymers belonging in the field of plastics. It was learned that many of these could be compounded or modified to give rubberlike elastomers. The materials performed so well in their new fields of application that the number of synthetic elastomers tripled (111). The latitude between the rubber and plastics industries is growing smaller, and competition keener, with each new development (112).

PROCESSING AND TESTING IMPROVEMENTS

The work accomplished in 1946, with electronic high-frequency preheating and vulcanizing has developed considerable data. Reports show substantial reduction in time required for vulcanizing and more uniformity of cure throughout the finished vulcanized product, rendering improved physical properties. Greater production per unit of molding equipment by this so-called "heatronic" method appeals to the industry, not only for the obvious reasons but also for the effects on labor (113 to 115). The method makes possible the uniform vulcanization of rubber parts of extremely heavy sections, in a fraction of the time consumed by the conventional platen-press or pot-heater methods.

Forward strides have been reported during the past 12 months in transfer and injection molding. Both accomplish the production of mechanical rubber-goods parts of superior physical

properties along with a reduction in curing-time cycles. These molding methods also make possible a higher degree of accuracy for precision parts having rubber-to-metal adhesion inserts (116 to 119).

A contest held under the auspices of the Chicago Rubber Group on "The Utilization of Cured Synthetic Scrap" brought forth many interesting methods, some of which were published. The Lancaster-Banbury method of devulcanizing mixed synthetic and rubber scrap is claimed to produce at reasonable cost a reclaim with properties comparable to those obtained by the more elaborate conventional methods of today (120). Since, in the past few years, we have produced little else but GR-S, it has been predicted that our supply of natural-rubber scrap will diminish rapidly, and that in 2 years a preponderance of reclaim will necessarily be GR-S. Therefore the urgency of solving this problem is apparent, as reclaim plays an important part in our national economy (121).

Many thoughts have turned to the reclaiming of scrap, mixed and sorted, and an economical procedure is reported for dealing with this scrap by using effective reclaiming oils or organic liquids (122 to 125). It has also been disclosed that success has been achieved in the utilization of cured synthetics as scrap (126).

New innovations in continuous Buna-S preparation and continuous coagulation of Hevea latex have been reported (127, 128). Hevea-latex storage over long periods of time had not been investigated before the war. Data disclosed on preservation methods prove that natural-rubber latex can be successfully stored for more than 4 years (129).

Data have also been published on the recommended GR-S and natural-rubber ratios that result in abnormally high modulus values (130). For the first time since the end of the war, a comprehensive set of wartime rubber-production figures has been released (131).

An avalanche of new laboratory and factory production quality-testing methods appeared in the year's literature. Methods and measurements of hysteresis in ubberlike materials have been disclosed (132). A new laboratory test method is reported for measuring the low-temperature stiffening of various elastomers (133), and also an improvement in apparatus for low-temperature brittle-point determination (134). Another laboratory technique, employing temperatures from —50 to 200 C, has been perfected to demonstrate the effect of gaseous environment on dielectric strength, and more specifically, to evaluate the role of oxygen as a fundamental factor in dielectric failure on synthetic and natural rubbers (108). A separate evaluation method of the effective temperature and of oxygen concentration has been accomplished by comparing the results of both air-oven and bomb aging at each of two temperatures, —80 and 100 C (135).

It is a recognized and accepted fact that there is no correlation between durometer hardness and static compression modulus of vulcanization. A real need therefore existed for many years, to enable rapid checking of modulus on production parts; such as automobile-engine mountings. A factory device has been developed claiming to accomplish this (136).

A variety of new tests for diverse products made of natural and synthetic elastomers, developed by the U. S. Navy, has been published. Many of these tests are applicable to general-line items (137).

Laboratory methods of setting up accelerated weathering with ultraviolet radiation and dynamic flexing of elastomers are constantly being devised as the art of rubber-processing advances (138, 139). The advantages of waxes in retarding weathering have been correlated on a new stretching-type test machine (140).

New techniques with a compression plastometer are possible, and information about the rheological properties that are commonly obtained with a compression plastometer can be supplemented if a few additional readings and calculations are made (141, 142). Details of a puncture-tear tester for rubberlike materials have also been made available (143).

Laboratory testing methods for a quantitative measuring of the state of cure can be performed by using a slight modification of the A.S.T.M. method "B"—Standard No. D-395-40T (144).

It has been concluded that the state of cure of neoprene vulcanizates can be determined by the rate of recovery of "racked" samples (145).

A microscopic technique has been disclosed which permits visual observation of structural changes of natural and synthetic rubbers during mastication and their subsequent recovery (146).

Of value to production departments is a new method made available for cleaning vulcanizing molds. Use is made of a soft grit obtained by grinding up corncobs. This grit, when blasted under air pressure against the molding surfaces, does a thorough cleansing job without any injury to the molds (147).

DEVELOPMENTS IN COMPOUNDING INGREDIENTS

The 1946 report of the discovery of an entirely new class of nonsulphur vulcanizing agents for the butadiene-styrene copolymers has been of tremendous interest to the rubber industry's compounding chemists. This new class consists of halogenated compounds which may be divided into three types: (*a*) Halogenated aliphatic hydrocarbons, containing at least one $—CX_3$ group, where X represents chlorine, bromine, or iodine; (*b*) halogenated aryl-methyl compounds, containing at least one halogen in the methyl group; and (*c*) aliphatic compounds, containing a $—CX_3$ group and another reactive group, such as ethyl trichloroacetate. Each of these types behaves somewhat differently with respect to activation by metal oxides and other substances, but all will give vulcanizates having high moduli and good tensiles. The vulcanizing agents of the second type are of particular interest since by their use vulcanizates of unusual aging properties can be produced. These vulcanizates show no increase in moduli or decrease in elongations on 1 to 2-day 100 C oven-aging, and sometimes even show reversion on aging, which is a very unusual phenomenon for GR-S (94).

Other nonsulphur vulcanizing agents, designed expressly for use with some of the newly modified GR-S copolymers, are now available. In general all of these agents impart faster curing rates than does sulphur (148). However, some actually enhance the physical properties of the finished product by lowering the hysteresis index and bettering the heat-stability characteristics (105). Light-colored and white GR-S stocks show great increase in tensile when compounded with triethanolamine.

Much has been recorded over the past 12 months to improve the physical properties of stocks of natural and synthetic polymers through the use of new compounding ingredients and methods (149). The study of structural changes, resulting from milling and subsequent recovery, has been reported explaining variations in factory batches (146, 150 to 154).

Compounding variables that influence tensile strength in vulcanized rubber and the problem "Why is one rubber stronger than another?" have been reported and the factors which affect this property, such as polymer chain-length relation and molecular weight, have also been revealed (155).

The use of certain activators with pure GR-S stocks is claimed to increase the tensile value and promote better aging resistance (156). GR-S stocks with improved characteristics for wire and cable extruded coverings are affected by compounding with various mineral pigments (88).

Carbon blacks, the mainstay reinforcement for synthetic and natural rubbers, have been improved and further studied to aid compounders in their problems of mixing stocks and bettering the vulcanized properties (9, 43). The important work on blacks can briefly be summarized as follows: The resultant effect of pelletization (7); the effect of variable quantities of black and softeners (6); the aiding of black dispersion (42); the influence of acetylene black on the electrical properties of GR-S (157).

In the past, rubber compounders have desired a reinforcing agent for light-colored and white stock that functioned as well as carbon black does for black stocks. Two announcements were made during the year that should prove to be of both interest and value. One is a light soot called "white carbon black," produced by the combustion of ethyl silicate (45); the other is a superfine silicon dioxide, produced by the combustion of silicon tetrachloride (158).

Noteworthy also to the compounders is the work reported on the following: The use of alkyl-phenolic resins as tackifiers (159); the use of styrene-diene resins (160); plasticizing with various active chemicals (161); influence of polar compounds (glycols) on hydrated calcium silicate and GR-S vulcanizates (162).

Some fundamental studies on the oxidation of GR-S, as well as other elastomers, is revealed and alkaline materials as accelerators for GR-S are compared in order to determine the effect of more strongly alkaline materials, finally promoting vulcanization of GR-S at room temperature (43, 163).

Also reported in the literature is the work done on the simultaneous incorporation of pigments and plasticizers in the form of premixed preparations (164). This incorporation is based upon the ratio of the materials used in such premixed preparations and is the deciding factor in their usefulness. For each filler there is a fixed ratio.

Considerable work was also reported on compounding of latex (165). Work has been done on black and nonblack pigments in dispersions for compounding (166). Lignin is being used as a reinforcing agent with effective results when incorporated in latex by the master batching procedure. GR-S shows outstanding properties for tensile strength and tear resistance when so compounded (167).

It is claimed that Buna-N latex is finding use in reinforcing a variety of fibrous materials.

SUMMARY

The conclusion for a year's summary paper such as this should not bear on the work reported during the past year but should list next year's "needs" or "wants" or both the rubber manufacturers and the rubber users. Paramount under the heading of "wants" is a definite national policy from the Government on synthetic and natural rubber. Under "needs" the classic problem of the chemical reaction of vulcanization remains to be solved in order to open up new avenues in compounding approach. Next in importance in the authors' opinion is the need for a method of reducing to a minimum the Joule effect on vulcanized elastomers, or a means of compensating for it mechanically in various products. Also needed is a synthetic rubber having extremely high efficiency along with a degree of oil resistance surpassing that of any of the present-day so-called oil-resisting elastomers which either swell or shrink excessively and are high in hysteresis index. Further required by the rubber manufacturers is a class of vulcanizing agents that will produce optimum cure to stocks of natural- and synthetic-rubber blends.

It is the authors' prediction that some of these "needs" and "wants" will become a reality before the end of 1947.

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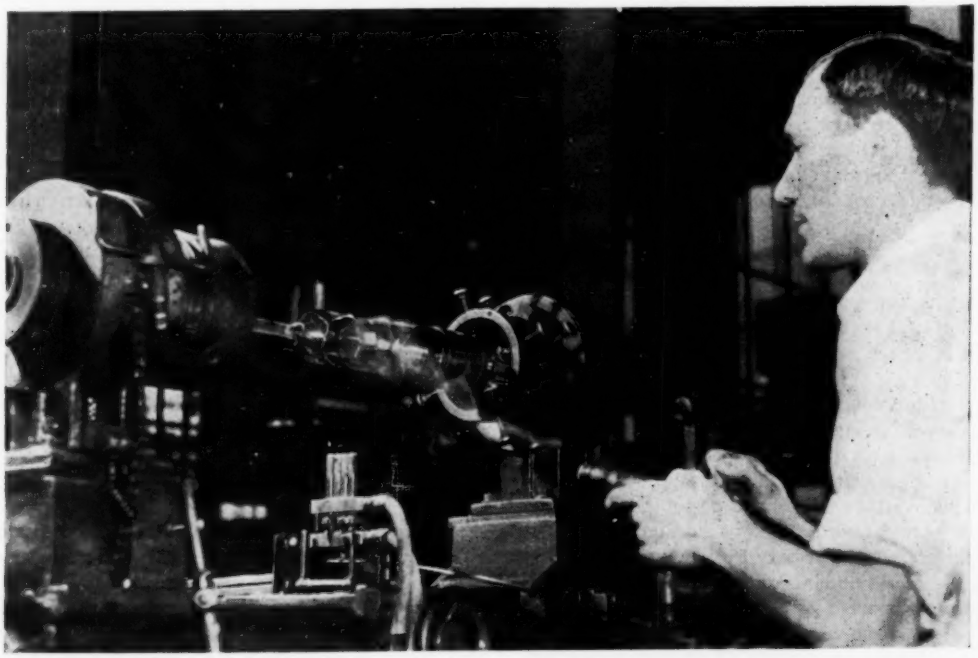

FLAME THROWER

(Wielding a torrid gas jet at the Mount Vernon, N. Y., plant of North American Philips Company, Inc. Operator shown in the process of "sealing-in" a rotating-anode x-ray tube. Here the anode and cathode (two separate glass assemblies) are joined together. Head and tail stocks of this special lathe rotate accurately in unison.)

DESIGNING *for* PRODUCTION—*a* PROBLEM *in* EDUCATION

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THE problem of preparing men for an engineering career in industry has been discussed by educators, practicing engineers, and by various societies for many years. There is no simple answer to the problem and it is obvious that the education and training best suited to the needs of certain types of industrial organizations, often differ from the kind of training that would be preferred by some other organizations.

Engineering students themselves further complicate this problem by being possessed of all the variations in traits and abilities that are characteristic of normal human beings. The majority, by virtue of their own tastes and abilities, will seek the less strenuous levels of education, and will tend to specialize in some particular branch of engineering while they are still in college.

The result is that any engineering school is faced with a most difficult problem. The nature of engineering is such that this problem is not readily solved by the methods used for training physicians and other professional people where the student is required to obtain an advanced degree in his profession. The practice of engineering requires so intimate a knowledge of industry that the only practical way for the student "to win his spurs" is to serve an apprenticeship in industry, and this is the usual method by which engineers are developed. There is today, however, a drift toward providing a broader, more fundamental, and liberal education for the undergraduate, and in some institutions this is resulting in the five-year engineering course.

A part of this broad problem of engineering education is the problem of providing the student with some of the skills he will need to exercise as an engineer in industry. A substantial portion of engineering graduates eventually find themselves practicing the art of designing for production and it is the preparation of the student for this kind of work that is the subject of this paper.

THE PRODUCTION DESIGN ENGINEER

The production design engineer has the design responsibility for a product that is substantially past the development stage and which is either going into production or is established in production.

In large organizations such a man may also have the supervisory responsibility of other engineers and a complementary drafting force. He will be responsible for the methods and routine of transmitting engineering instructions to the manufacturing organization. His vital and prime responsibility, however, is exercised when he releases a design (or a design change) for production. At that moment he may be committing his company to an expenditure of hundreds of thousands of dollars that will be spent for raw materials, castings, tools, and all the "fodder" of industry. It may be six months or even a year before the product he has released comes off the production line, and it may be another year before he will really know whether the product has successfully met the test of service in the hands of the ultimate user. Meanwhile, the liability borne by his company may run into millions of dollars. Obviously this is no light responsibility.

Contributed by the Education Committee of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

FUNCTIONAL DESIGN AND PRODUCTION DESIGN

During the war perhaps the most outstanding lesson that could have been learned by European designers was the need for production design. The production facilities of the United States literally swamped the continent with bombs dropped from airplanes that were produced with our mass-production technique. The technique of production design was one of the vital factors that made this possible.

American designers, too, should have learned that functional design cannot safely be subordinated to production design. The British Spitfire airplane with its Merlin engine affords an excellent example of functional design in which the characteristics sought were achieved regardless of the manufacturing difficulty, and with the ultimate result that a handful of these airplanes successfully held at bay the numerically superior German Air Force. The jet engine, the buzz bomb, the rocket, the new designs of radar equipment, and finally, the atomic bomb were all examples of impractical things that were accomplished in spite of the practical difficulties. The engineer, even the production design engineer, must not be too prone to sacrifice functional performance for practical limitations in manufacturing. Well-balanced judgment is required.

As an educational problem, the task is one of developing in men the skill and creativeness essential for the art of production design; to equip these men with the necessary knowledge of mass-production techniques and the design features associated with them; to provide them with a sound training in engineering fundamentals, and further to strive for the development of sound judgment so that the young man can assume the responsibilities involved as early in his career as possible.

PRODUCTION DESIGN DETAILS

The specific art of production design is only one phase of the activities of a production design engineer, but it is an extremely important part of his work and is the kind of activity that most young engineers in the production design field pass through as they progressively assume more responsibility.

Some phases of production design details are discussed in what follows to give a clearer picture of the educational problem:

The Art of Dimensioning. One of the most common of practical design problems is that of showing dimensions that will accomplish the desired result and still be practical. Consequently, it is extremely important that dimensions be shown in such a way that: (*a*) The part will always perform its function and assemble properly if made within the dimensions shown. (*b*) The dimensions cannot be interpreted to give different results. (*c*) The machining and processing can be done by practical available methods that will produce the accuracy

required. (*d*) The inspector is able to measure the piece by practical methods and know whether the dimensions are within tolerances. Dimensions from imaginary center lines or surfaces that do not physically exist should be avoided.

The Selection of Materials. The selection of suitable materials is highly important in any design. It is one of the "details" on which a great amount of thought and effort must be placed.

Functional Details. A functional detail is one which affects the functioning of the machine being designed. Production design work is full of such details which must have careful attention. Even the man in a highly responsible position, directing the work of many other engineers, must be able to recognize at a glance the important functional details in a design and see that the design work properly takes care of them.

Designing for Cost. Cost, in competitive enterprise, is of first importance. Low cost, however, is not worth the saving if it is obtained at the expense of quality, or by mere cheapening of the design. It must be obtained by improving the design—by making one part do the job of three or four—by simplification and ingenious arrangement. Properly designed, the best design will also be the one of greatest simplicity and lowest cost.

It is emphasized that only practice in the art can bring proficiency. For that reason, it would seem that engineering schools might profitably introduce some of the methods of the art schools and architectural schools in order to develop in the student such latent talents as he might possess. Many young engineers tend to avoid design work merely because they have not been exposed to it, and are afraid that they do not possess the talents. The result is that much of this work is done by draftsmen; and engineering organizations are frequently composed of an assortment of practical designers and technical engineers, neither of which fully understands the other's point of view, and both of which have undesirable limitations. It would seem that some practice in the art of design during college training would be worth while.

KNOWLEDGE, SKILLS, AND PERSONAL ATTRIBUTES

Mention should be made of some of the other attributes the production design engineer should possess; and the education problem should be discussed, so that the entire problem may be viewed in proper perspective.

Practical Knowledge. A thorough knowledge of materials, their physical properties, machinability, forging characteristics, suitability for casting, corrosion resistance, and other properties is essential. It will be found, however, that this subject is extremely difficult to teach because of the vast amount of information needed and because any methods which teach this subject in the abstract are bound to be monotonous. The knowledge of materials that comes by the study of metallurgy is more easily acquired because the knowledge comes as a corollary of a scientific pursuit. Perhaps the study of metallurgy is one of the best ways to teach this subject. If this is not practical, however, the young engineer can best learn his materials by actually doing design work in the course of which he must make intelligent selections of materials.

All of the shop processes such as anodizing, passivating, bonderizing, lacquering, and sandblasting are important techniques that the designer must know about. Similarly, the skilled trades such as pattern making, machining, foundry practice, die casting, forging, toolmaking, and die-making must be at his fingertips from the standpoint of knowledge. It is not necessary and obviously would be practically impossible for a man to be skilled himself in each of these trades, but he must know their limitations, their advantages, their adaptability to different materials, and their relative cost.

Industrial processes such as hot pressing, extruding, blooming, rolling, drop forging, drawing, brazing, machine welding, and many others are a part of the lore of industry with which the young designer must become familiar. Again the problem of education is difficult, for subjects such as these are apt to be mere words on paper when they are put into textbook form. Direct observation and experience is perhaps the best method of teaching, but a good compromise might well be developed by the use of motion pictures which would visually describe these various industrial processes and trades.

Knowledge of Engineering Fundamentals. Another field of knowledge that is essential to the engineer is that of engineering fundamentals. This knowledge, of course, is of little use unless he also has the ability to use it.

The subjects that are normally thought of as comprising engineering fundamentals are mathematics, elasticity, plasticity, fluid flow, heat transfer, physics, dynamics, strength of materials, chemistry, thermodynamics, and other subjects of a fundamental nature. If a man is endowed with analytical ability these subjects are relatively easy to teach except for the fact that they do require some hard work on the part of the student.

Unfortunately, the value of fundamental knowledge to the production design engineer is often underestimated. Even when the fundamentals of a design are worked out by the development engineer, the production engineer seriously limits himself unless he has a thorough command of the fundamental relations in the design.

Ability for Mechanical Design. The production design engineer must have a mastery of the art of design. If this subject is recognized as an art, there is no reason why it should not be taught as such and by the same methods that are used to develop musicians, painters, and architects. No reputable art school promises to make an artist of the art student, but it can provide him with the technique, the inspiration, and the tutelage that will develop whatever latent talent the student possesses. It would seem that the same methods of teaching should be used for students of engineering design.

Knowledge of the Industrial Organization. There has been much debate concerning the value of training in industrial management, including courses in accounting, organization, planning, cost finding, machine tools, factory processes, and similar subjects. However, it is felt that the student of design engineering whether he emphasizes production or development, simply has not the time in four years of college to absorb both subjects unless he neglects his liberal education, which is much more important to him.

Actually, factories today are so complex that there is a definite need for men with professional training who may be called Factory Engineers, and who will bring with them specialized knowledge of factory processes, tool design, machine-shop practice, rate setting, and a host of other subjects common to our factories today.

It seems that Factory Engineering is of necessity a course by itself in so far as college training is concerned. Consequently, it does not seem wise to attempt loading the design student with courses in industrial engineering except to the extent that he is given some knowledge of industrial processes and trades so that he is aware of their advantages and limitations in his design work.

The Art of Communication. The production design engineer spends a large share of his time in communicating with others. He uses drawings, instructions, letters, telephone, telegraph, lectures, and conferences in order to spread his ideas and give them effect. Consequently, a fluent and precise command of all forms of communication is a great asset. Sound training in the use of English should form an important part of his college training. Since precision of thought and expression are probably

more important than fluency, there may be some advantage in emphasizing this in his training.

Analytical Ability. The ability to analyze problems effectively and to reach sound conclusions is necessary in practically any field of engineering, and production design is no exception.

A man's analytical ability is further enhanced if he is also a good diagnostician. In other words, he should possess the ability to select the related facts in a situation and to arrive at a sound conclusion on the basis of those facts, with assurance that he had not overlooked other significant data.

Creative Ability. Creative ability beyond that needed for the art of design, such as the creation of new methods for making things, the invention of new products or product components, and the creation of new arrangements of the components of a product is always of benefit to the designer.

The Ability to Plan. Perhaps the most important single concept in industrial activity is that of time. The engineer must have sufficient skill to predict, with reasonable certainty, that the engineering activities for which he is responsible will be completed within the time allowed by his commitment. This ability to organize so that diverse activities are properly synchronized, coupled with the ability to foresee a pattern of events in the future for which preparation must be made, and the ability to put a time value on the completion of each of those events is the ability to plan. An engineering college should give the student assignments that will cause him to plan his activities; the student's habits of meeting his commitments promptly should be cultivated all through his college career.

Initiative. In many industrial organizations the engineer is in a position where he is primarily responsible for initiating activities. Usually it is the engineer who proposes a new product or some new modification. Unless he takes the initiative in presenting his ideas, nothing will be done.

Initiative is scarcely a subject one can teach by formal means, but it is possible to give students their work assignments in such a way as to stimulate and cultivate this trait. Assignments of creative work all tend to stimulate initiative, and extracurricular activities can also be designed with the same purpose in view. Attention to the needs of the individual student will often be indicated. Promoting initiative is difficult but much can be done in college if the effort is made by the faculty.

Supervisory Ability. As the responsibility of a production design engineer increases it is only natural that he will be called upon to supervise the efforts of others. This is true in practically all industrial organizations today and is a matter of sheer necessity, because the work that any one man can do is limited and he must rely on the co-ordinated efforts of others to produce results.

The ability to supervise, of course, is one that depends more upon the personality and character of the individual than upon technical accomplishments. Consequently a man of high technical achievement is apt to be handicapped in an industrial organization unless he also has a well-balanced personality. If a man chooses to enter the field of production design, it is almost necessary that he be capable of developing supervisory ability if he wishes to achieve continued success.

Judgment. The importance of good judgment to the production design engineer should be strongly emphasized. Often he is in a position where he must make a decision either to stop production and correct some deficiency in the product at the factory, or to continue shipments and make arrangements for campaign changes after the products are shipped. Actions of this sort are drastic in any case and can lead to substantial losses unless the best of judgment is used.

His character must be firm enough to permit him to exercise his best judgment in the face of strong opposition, and his judgment must not be impaired under the pressure of an emergency.

This characteristic is one that a capable man will naturally develop as he gains experience. To the student, the important thing is to recognize that industry will expect him to exercise this judgment. He should prepare himself accordingly.

Other Characteristics. Other personal and professional characteristics could be mentioned and discussed. Certainly, some readings in the history of philosophy and in the classics would be of value to any student in helping him to develop his own character, but whether there is time for this in an engineering curriculum is a moot question.

The really important point is that each student must be considered as a complete individual and the study of any one part of his curriculum must be kept in proper perspective to all of the attributes and characteristics he will need to develop during his professional career.

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(*Continued from page 372*)

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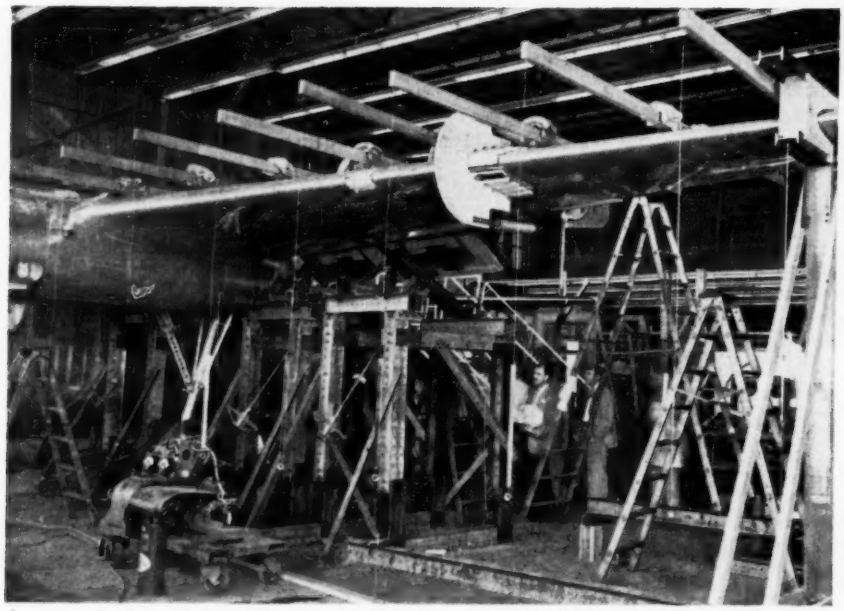

SETUP FOR STATIC TEST

ENGINEERING RESEARCH LABORATORY MANAGEMENT

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INTRODUCTION

IT HAS long been the impression of many that the management of research operations is different from the management of other types of business operations. In general, this is usually due to the fact that the ordinary businessman does not have a clear conception of what can be done by research organizations and because research men in general do not have the ability of expressing complicated technical terms in simple statements which can readily be understood by those who do not have a technical education or experience. Because of the tremendous increase in expenditures for research during the war, and because of the entrance of the Government into the domains of private research, it has become necessary, more than ever before, to put research operations on a sound business basis. It has also become necessary to present research as a business venture in which the probability of obtaining useful results in a definite time must be assured.

Part of this paper deals with systems used in the Engineering Research Laboratory of the author's company. Other laboratories may have different names for some of the controls. In general, the data presented are the result of associations with many research managements.

When stripped of its embellishments, engineering research is simply a process of solving difficult technical problems. The process is straightforward. The first and often the most difficult step is to define the problem or find out what is desired; once this is definite, the next step is to obtain a background of information which has been accumulated as the result of the work of others. This is accomplished by personal contacts, study of the literature, study of patents, etc. Much research can be concluded if these data are studied, and it is possible to reach the desired conclusions. In many cases, however, the particular data desired are not available and it is necessary to conduct laboratory experiments. This step in the research process is very costly and, unless careful control is kept of laboratory operations, large sums of money can be wasted.

This discussion is concerned with "engineering research," which is a special blend made up of exploratory research, development research, production research, and product evaluation. Exploratory research is necessary in order to uncover new fields which might prove valuable for new types of business developments in the design of new products and the improvement of old products. Development research is necessary in order to provide data which can be used for designing products. Ordinarily this type of research is the extension of existing principles and the accumulation of data which are based on information already available and on definite laboratory experiments in which the type of results can be predicted before the laboratory work is accomplished. Production research is conducted to provide better methods of producing company

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products and to provide designers with new means of construction. Since the greatest expenditure of most companies is spent for manufacturing operations, this is a fertile field for effecting cost reduction by research.

An important part of the engineering research type of operation is that of evaluating designs of items which have been made by the engineering department or made by other companies, and which will be used on one's own product. This type of work is particularly important to a research organization, because it clearly shows research personnel what is required to improve the company's product. Last, but not least, is the testing of the final prototype of an item for production. This provides all concerned with an unbiased accurate estimate of the worth of the company's product as well as a datum plane which will be used in the design of the next and improved prototype. The inclusion of this type of work in an engineering research operation is a balance wheel which keeps the organization on the path to profitable and useful results.

There are many special problems associated with engineering research which are not encountered in other types of research operations, such as university research, or in research for an industry which is confined to a limited number of simple products, or in a basic research operation. The most important problem is that of obtaining personnel with special characteristics. They must have an excellent technical background so that they can think clearly in several different fields. It is also necessary that they be able to co-operate with engineers who, by the nature of their training, are reactionary, and on the other hand, they must be able to keep an optimistic viewpoint required for exploratory and creative research.

The second most important problem is that of co-ordinating the research of several groups in an engineering research laboratory. Such a laboratory is usually composed of several widely different technical categories, such as, electrical engineering, chemical engineering, mechanical engineering, metallurgical engineering, structural engineering, and applied physics. Usually no single group can present the most economical solution to a problem. It is necessary to integrate the activities connected with the individual problems, but still center the activity in a particular group.

A third special problem has to do with the providing of materials and facilities. It is necessary to provide a much more complicated administrative service than for an average factory. Most of the equipment and materials which are required are special and unusual. It is necessary to relieve the professional personnel from the lengthy searches required to obtain material and to follow up on purchase requisitions and orders.

A fourth special problem is that of the maintenance of satisfactory public relations with other branches of the company as well as with governmental agencies, customers, and the public at large. Public relations is of particular importance in engineering research because the final product to be manufactured by the company has been based on laboratory data, and public acceptance of this product is of vital importance to the company.

There are several other points in connection with engineering research laboratory management which need particular emphasis and must be constantly recognized by research laboratory management. In part these are as follows:

1 Emphasize the importance of obtaining results rather than the techniques of obtaining results. There is a tendency for research personnel to spend considerable time in devising equipment and improving techniques of obtaining desired results. Sometimes the cost of such improvement far outweighs the advantages to be obtained; also the time required to obtain the results is usually extensive, and the cost of a given project will be increased beyond reason. In this connection, a careful examination of personnel will show that there are certain types who are more interested in the development of equipment and techniques than in solving technical problems. Such personnel should be used on problems requiring such talents.

2 Emphasize the scheduling of research personnel's time. This is necessary so that no time will be lost when experiments are being run and so that all personnel can be utilized fully. In many instances, it is not necessary to wait until experiments are concluded before reports are started; in fact, if the introduction, purpose, and procedures in reports are written prior to running the experiments, a more straightforward experimental program will probably result.

3 Provide research personnel with adequate tools for research. There is a distinct tendency to hire expensive research personnel and to deny them adequate tools with which to work. It is probably a better policy to provide more tools than are required, because if there is a wider variety of research tools available, programs can be planned which will utilize the one which is the most effective. It should not be considered inefficient in a research laboratory to have a few pieces of good equipment idle part of the time, because the occasion always arises when a rush job should be done without destroying a complicated setup in a machine.

4 Considerable effort should be made to fit the research job to the personnel available. There has been a tendency by some businessmen to feel that if funds are expended in a research laboratory and the results have been negative that the problem could not be solved. Often this is erroneous because the project was conducted by someone who was not fitted for the work. As the course of experimental work becomes hazy or indefinite, or if it is prolonged without definite results, it can be considered an indication that the job has not been suitably fitted to the personnel conducting the work. It is better for laboratory management to refuse to do projects for which the organizations facilities are inadequate, rather than to spend funds under false pretenses.

5 Especially during the war we had to emphasize the importance of maintaining active technical contacts with competitors and with the technical organization of other industries. It is desirable and a good policy to work with the research managements of competitors in order to solve problems which are noncompetitive within an industry, but which may be competitive with other industries. Also the ramifications of research today make it necessary to be aware of developments in almost all fields because of direct applications to one's own industry, and because of analogic applications. Many companies have one or more research men of high caliber who make periodic visits to outstanding laboratories.

6 Laboratory management must be constantly on guard that the laboratory is not exploited to conduct research for those who have something to sell the company. Individuals and organizations have ideas which are only partially crystallized; these ideas have merit and on first thought it might be felt that it would be desirable to conduct work on them in the laboratory; however, as a sound policy, it is better to insist that these individuals or organizations have the items developed and tested elsewhere, unless there are excellent business reasons for assuming full responsibility of the development of such projects. The testing of any vendor's part by a research laboratory should be scrutinized closely by research management and checks should be made with other companies to determine whether similar-type tests have been run.

7 It is a duty of research management to promote active cooperation between personnel of comparable levels of organization in the research department with those of other technical departments of the company. In general, a good rule to follow is that the next higher level of management is responsible for

promoting the co-operation between those in the level just below.

8 In reporting results of tests on items of interest to other departments in the company, great tact must be used so that no ill feelings will arise from results and conclusions. In many cases, it is better merely to present the results of tests and permit personnel in other technical departments to draw their own conclusions as to the value of items on which experiments have been conducted.

9 Much has been written about the necessity for research management to sell "top" management of the company on research per se, and on the necessity for hiring competent specialized personnel for certain problems. This is an ever-continuing job, and is so because of the nature of research. There are only a few organizations which have "top" managements that are actually pushing research management to do more research, so the burden of effort in most cases will remain with the research director.

Before entering upon a description of systems in connection with research management, it should be pointed out that research management should keep as many of its activities as logical as possible. Research personnel are trained to think with ice-cold logic and when they are confronted with what they think are illogical acts by research management, there is a natural resentment and depreciation of the quality of management. If it is necessary to act illogically, or to do what may appear to the majority as illogical, it may be expedient to explain that such actions are required by governmental, business, contractual, or policy requirements.

BUDGET PREPARATION AND CONTROL

In order to manage an organization which may have more than a hundred research projects at one time, it is necessary to have adequate budgets which are properly controlled. The requests for research budgets ordinarily originate wherever the need for solving problems originates. Predominant among these are the sales department, engineering department, service department, and the engineering research laboratory itself.

In general, the research budget is made up of two types of projects, one of which is concerned with general and exploratory research on long-range problems, and the other is concerned with applied projects pertaining to items of manufacture. The general research budget usually is a lump sum provided by management, while the project budgets are closely tied into factory and engineering projects. It is usually expedient for a company to have a research committee composed of representatives of top management and who are from the sales, engineering, factory, service, and research departments. The composition of the committee is such that they can study and decide which of the research problems drawn up by the research-department management would be most useful to the company as a whole, and which if successful would be of most benefit to the company.

Proposals for general research may originate in any part of the company organization; however, they usually originate in the research department or from those closely allied with the research operation. These are prepared on a form which outlines the general problem requiring solution; the general type of operation, which will have to be carried out to obtain such a solution, an estimate of the funds required, and other data which must be considered in connection with the proposal. After discussion with others concerned, these are submitted by the research director to the research committee along with other research proposals for a given budget period.

The basic authorization for the expenditure of funds is the "work order," which expresses the broad basis for which the funds are authorized. It is primarily for the use of the accounting department and to provide "top" management with general information concerning the proposed expenditure. It also provides a record of the signatures of all concerned who have authorized the expenditure of the funds.

On the basis of research proposals which have been approved by the research committee, or other similar types of authorization, "engineering work assignments," are prepared. These assignments break down the research operation into various problems and usually provide for the assignment of the problem to specific groups in the research organization. The assignment outlines in a broad way the problem and the limits. It also allocates definite funds which can be spent on the project before additional funds must be provided, and it budgets these funds in so far as expenditure is concerned for the various research groups, laboratory shop, and expenditures for materials. The engineering work-assignment number and the work-order number are utilized in accounting operations.

The amount of expenditures made by various groups on all of the engineering assignments are accumulated each week and reported to management. The actual number of hours spent by each person on each project is obtained daily by means of time-distribution cards. In the case of professional personnel, these are usually checked by lead engineers or group engineers and, in the case of nonprofessional personnel, they may be filled out by the timekeeper or the department clerk. These in turn are punched on an IBM machine and the hours spent are automatically typed on tapes.

Weekly status reports for each project are prepared. These are distributed to each research supervisor and to research management. As a result of the study of these data, it is possible to have an accurate check on research expenditures at all times, and it is easy to determine which projects have been neglected and which have been overemphasized and deviate from the preliminary planning.

It is important that the mechanism for obtaining work assignments and supplements to work assignments be flexible so that they can be obtained without excessive red tape and many authorizations. Ordinarily, the research director's approval should be sufficient.

Budgets for projects for research which originate in connection with company products usually are the result of agreements between research-management personnel and the other departments concerned. The work order for these projects is in general the work order for the product being developed and engineering work assignments are usually authorized by the heads of the two departments concerned.

PROJECT PLANNING AND CONTROL

To control the budget is relatively easy because it is almost free of the human element, but to control the technical course of a research project is more difficult. The engineering work assignment ordinarily places the responsibility of the over-all supervision of a research project on a research supervisor or group research engineer. The supervisor is responsible for reassigning portions of the problem within his own group and is also responsible for obtaining any other additional help that might be needed to complete the work authorized by an engineering work assignment. It is necessary for him to arrange for portions of the work to be done by other groups, by the laboratory shop, or by outside organizations. The co-ordination of the work with all concerned is, in general, the responsibility of the research supervisor. He is also responsible for the planning and approval of the plans for laboratory operations which are within reasonably broad limits.

The actual research work, whether experimental or literature searches, is conducted by research engineers and their assistants. In general, it has been found expedient to assign only a

limited number of problems to each research engineer. The number of assistants whom he might have to help him depends upon the project. In some cases, it might be as high as fifteen or twenty, while in other cases it might be only one assistant; or he might do all the work himself.

The research engineer is responsible for detailed planning, analyzing, and executing assigned research jobs. These assignments usually are made in writing by the research supervisor so that there is no misunderstanding as to who is responsible for executing the various portions of the projects. The research engineer in turn makes detailed outlines of the research procedure to be followed, plans experiments, and co-ordinates the work of others who might be assigned to assist him in the projects. In many cases, it will be necessary for the research engineer to design special equipment for the experimental work necessary for the successful solution of the problem, and, since the research engineer usually is the best informed specialist on the problem, it is necessary that he draw conclusions and make recommendations as a result of his work.

Groups concerned with large product-development programs are informed of the status of various projects assigned to the research department by means of "planning co-ordination schedules." This shows the title, estimated cost, the scheduled completion date, the amount of work which should have been completed on the date the report was issued, the actual and percentage of completion.

The technical course of the work is charted by means of status reports written weekly or semimonthly by each individual research engineer. The status reports are assembled by the research supervisors and forwarded to the director for study and for redistribution; in specific cases, to others interested in special problems. The management of the company as a whole is kept informed of the results obtained in the research laboratory by means of monthly progress reports prepared by the research supervisors and by means of final reports on various projects.

THE RESEARCH OPERATION

One of the most important duties of the management of an engineering research laboratory is to provide a system for the smooth functioning of the research operation. It must be recognized that research engineers and other laboratory technical personnel do not have the knowledge, contacts, or patience to carry out the business routine connected with the research operation. There is a tendency for technical personnel to become entangled in systems to the extent that it impairs their thinking. Therefore it is necessary to set up a strong administrative service group to supplement the technical talents of the research personnel and establish a buffer between research and accounting, industrial relations, purchasing, and similar departments.

One of the most important services which needs to be provided is that of making or obtaining special apparatus or equipment. To obtain such equipment, it is convenient to have the research engineer prepare a "research service request." This request serves several purposes, such as providing a correct charge for the work to be done; data which can be used in scheduling work; data which can be used in constructing the equipment, etc. These requests are processed by the service group. Copies are distributed to the work assignee, planning, files, the writer, and to the research supervisor.

In most cases the equipment requested can be made in the laboratory shop. The shopwork required is broken down into the necessary shop operations by an experimental planner in the service group. The scheduling of the work in the shop is arranged for in accordance with shop load and the urgency of the particular job. Materials required are also ordered by the planner, either from factory stores or from vendors. In many cases, the making of the equipment requires special shop operations and these are planned and arranged for by the experimental planners.

In general, the experimental planner is responsible for having the equipment made in accordance with the desires of the research engineer before the due date for the equipment. If it is necessary to have the equipment or part of equipment made outside of the laboratory shop, this is also arranged for by the experimental planner through the "outside production" organization of the factory. All follow-up work on outside-equipment-construction jobs is conducted by the experimental planners.

The successful operation of an engineering research laboratory requires an adequately equipped and well-staffed shop. There should be enough equipment so that most of the apparatus and specimens can be made in the laboratory. This makes it possible to provide apparatus on short notice to perform experiments which are often required before a research project can be continued. There are other benefits from having a shop, such as the ease with which work can be kept secret or confidential.

All materials and supplies required for research projects are obtained by the service group by means of "material requests," which are originated by research technical personnel or experimental planners. Often these materials are still experimental in nature, and it is necessary to make special arrangements with the purchasing department of one's own company, as well as the sales departments of vendors, in order to obtain such materials. It is necessary to have someone who is skilled in procurement follow-up work to keep in almost constant touch with vendors in order to obtain materials within the time that they will be usable by the research personnel. It is also necessary for the service group to make special arrangements for receiving and inspecting material and equipment ordered by the research laboratory. Because of the special nature of research items, they are often misused if they fall in the hands of factory receiving inspectors; for instance, special photographic materials have been opened in the light so the inspector could count the sheets. In general, it has been found desirable to request all vendors to include a statement on their packing slips that the material is special, and that the engineering research laboratory should be contacted before it is unpacked or inspected.

The necessity for speed in providing services cannot be overemphasized. Experiments often come to a point at which modifications or additions have to be made before progress can be accomplished. New ideas and plans often have to be exploited before a product is marketed. Tests have to be made before important military innovations can be sent to battle areas. These and other reasons require the utilization of shopper-buyers, shop follow-up men, expeditors, and a keen attitude by personnel of the service organization that due dates must be met.

When engineering research laboratories are associated with factory organizations, there is a natural tendency for other departments to want to furnish services to the research laboratory. Typical among these services are maintenance, protection, duplicating, and photographic. It is usually most satisfactory if these are performed by laboratory personnel or those assigned specifically to the laboratory. This is especially true of photographic services because photography is a research tool in addition to being used for illustrating reports.

There is a multitude of miscellaneous administrative services which must be provided for the research operation. This includes making arrangements for transportation, janitorial ser-

(*Continued on page 402*)

DISTILLING-PLANT ECONOMY

By A. M. IMPAGLIAZZO

ENGINEER, GRISCOM-RUSSELL COMPANY, NEW YORK, N. Y. MEMBER A.S.M.E.

RECENTLY published papers by Allen Latham, Jr.,[1] and M. L. Ireland, Jr.,[2] have renewed interest in distilling-plant economy, and in comparisons of the relative economy of the compression-type plants described by Mr. Latham with the conventional steam-heated types discussed by Mr. Ireland.

COMPRESSION DISTILLATION

The principle of compression distillation dates back to the nineteenth century. Periodically, advances in the art of its applications have given it a temporary popularity which then has disappeared as a result of the development of more economical arrangements of conventional types. These advances have generally been stimulated by extraordinary wartime conditions. A plant using a steam-jet compressor was built during the first world war and was tested at the U. S. Naval Engineering Experiment Station at Annapolis. A report on the results of the tests was presented by M. C. Stuart[3] in 1918. "Performance" approximating 3-effect operation of conventional-type plants was reported. The most recent development in this field employs a mechanical compressor, and its arrangement is shown in Fig. 1. "Performance" ranging from 5 to 15-effect operation, depending upon the type of drive, is claimed for this unit. This high "performance" has led to some erroneous conclusions regarding the economy of these units.

In order to avoid the confusion regarding terms which exists in the distilling-plant literature, the following definitions will be adhered to strictly in this paper:

"Steam-economy ratio" or simply "steam ratio" means pounds of distillate per pound of heating steam.

"Fuel-economy ratio" or simply "fuel ratio" means pounds of distillate per pound of fuel, based upon fuel having a heating value of 18,500 Btu per lb.

"Over-all economy ratio" means total cost (including cost of fuel, interest, amortization, care, and maintenance) of producing a unit quantity of distillate.

The steam ratio, very inappropriately called "efficiency" in distilling-plant literature, is useful only in comparing the performance of two steam-heated plants using the same, or a similar, source of steam. If the steam supply differs, two plants having the same steam ratio may have widely different fuel and over-all economy ratios. For example, consider two single-effect distilling plants both heated by steam at 5 psig; assume the first to be heated by exhaust from steam-driven auxiliaries while the second employs steam direct from a boiler. Both may have a steam ratio of 0.95, but if the heat of the auxiliary exhaust would otherwise be wasted, no additional fuel is required to operate the first distilling plant, and its fuel ratio is infinite. The fuel ratio for the second plant is approximately 15.

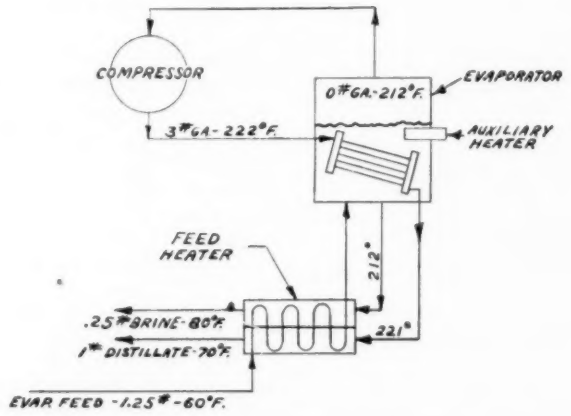


FIG. 1 TYPICAL COMPRESSION-TYPE DISTILLING PLANT

A comparison of the fuel ratio of the compression-type plant with that of the second steam-heated plant in the previous example permits the conclusion that the compression-type plant gives results comparable to a multiple-effect conventional-type plant. By the same reasoning, however, it may be stated that the first steam-heated plant results in a "performance" comparable to an infinite number of effects. There are very few industrial installations where the heating steam is taken directly from the boiler; hence the "performance" of practically all single-effect installations is equivalent to many effects. It is obvious that "performance" comparisons of this nature can become very confusing.

The over-all economy ratio provides the best means for comparing the performance of different types of plants or of similar plants differently arranged. The fuel-economy ratio is one of the factors affecting the over-all economy ratio, but not necessarily the controlling factor. The presentation of quantitative over-all economy ratios for various types of plants is beyond the scope of this paper since these depend to a large extent upon local conditions, and vary widely with the price and wage structure. This paper must necessarily be limited to a presentation of fuel-economy ratios and to a discussion of some of the other factors affecting the over-all economy.

PERFORMANCE OF "COMPRESSION-DISTILLATION" UNITS

The performance of compression-type distilling plants was discussed fully and ably by Mr. Latham.[1] The analysis which follows is based upon Mr. Latham's paper, and upon many discussions with operators in the field. Some of the material previously published is repeated for convenience.

In the operating cycle shown in Fig. 1 raw evaporator feedwater passes through a heat exchanger in which it is heated by the distillate and by the brine discharge. Evaporation takes place in the evaporator shell at atmospheric pressure and therefore at about 212 F. The vapor produced then is compressed to about 3 psig and discharged into the evaporator heating element where it is condensed. Its heat generates more

[1] "Compression Distillation," by Allen Latham, Jr., MECHANICAL ENGINEERING, vol. 68, March, 1946, pp. 221–224.

[2] "Economic Features of Low Pressure Evaporating and Distilling Plants for Merchant Ships," by M. L. Ireland, Jr., Transactions of The Society of Naval Architects and Marine Engineers, vol. 53, 1945, pp. 38–69.

[3] "Tests of Regenerative Evaporating Apparatus," by M. C. Stuart, *Journal of the American Society of Naval Engineers*, vol. 30, no. 1, 1918, pp. 41–59.

Contributed by the Process Industries Division for presentation at the Semi-Annual Meeting, Chicago, Ill., June 16–19, 1947, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

vapor in the shell and the cycle is repeated. The plant requires an auxiliary source of heat to produce vapor initially and to make up heat losses in excess of the heat supplied by the compressor.

The compressor and any necessary pumps may be driven electrically or by an engine. In the former case, auxiliary heat is supplied by electrical heating elements in the evaporator shell, while in the latter, it may be supplied by waste heat from the engine in a heat exchanger not necessarily within the shell.

The best performance of these units is illustrated by the following heat balance based upon the quantities and temperatures of Fig. 1:

	Heat in, Btu	Heat out, Btu
Evaporator feed[a]	35	
Compressor	35	
Auxiliary heater	35	
Distillate[a]		38
Brine[a]		12
Radiation, venting and other losses		55
	105	105

[a] Heat content above 32 F.

A heat input of only 15 Btu per lb of distillate would be required at the compressor for ideal adiabatic compression through the range indicated, but a minimum of about 35 Btu is required in the actual unit.

Within rather wide limits, compressor efficiency is of no importance in the case of the electrically driven unit inasmuch as any increase in heat supplied to the compressor is accompanied by a reduction in heat required by the auxiliary heater and vice versa. A total of about 70 Btu per lb of distillate must be supplied by electrical energy in any case. Assuming an over-all power-plant thermal efficiency of 25 per cent, the fuel must supply 280 Btu. This results in a fuel-economy ratio of 66.

In the engine-driven unit, where waste heat is utilized to supplement that supplied by the compressor, a fuel-economy ratio of about 160 is possible. A reduction in compressor efficiency has a direct effect on this ratio, however, since auxiliary heat comes from a source that would otherwise be wasted, and therefore a reduction in the amount required does not effect any saving to compensate for the increased amount of energy required by the compressor.

Scale on the evaporator-tube surfaces affects the fuel-economy ratios for the two types of drive in the same manner as compressor efficiency. As scale accumulates, the heat-transfer coefficient is reduced. In order to maintain the same output, the temperature difference across the evaporator tubes must be increased. This means that the vapor must be compressed to a higher pressure; hence more energy must be supplied to the compressor. This has little effect on the fuel-economy ratio of the electrically driven unit but does reduce that of the engine-driven one.

Average fuel-economy ratios of about 60 for the electrical drive and 140 for the engine drive may be expected in actual service. These can be obtained only at very low temperature differences (not over 15 deg F) between the compressed vapor and the boiling liquid. Unfortunately, at these low temperature differences, the heat-transfer coefficient is also very low. The cumulative effect of a low temperature difference and a low heat-transfer rate necessitates a large amount of heat-exchange surface in the evaporator for a given capacity. In addition, the brine outlet-feed inlet and condensate outlet-feed inlet temperature differences must be made very small, a fact which necessitates a large amount of heat-exchange surface in the feed heater.

These two factors, together with the compressor, result in relatively high fixed charges which affect the over-all economy adversely.

In order to maintain high average fuel ratios, venting and radiation losses must be carefully controlled, especially in the case of the electrically driven unit. All heat-transfer surfaces must be kept fairly free of scale. These factors result in relatively high maintenance costs.

PERFORMANCE OF STEAM-HEATED DISTILLING UNITS

For single-effect steam-heated plants where boiler steam is supplied directly to the evaporator, and where the heat of the evaporator vapor is absorbed by raw circulating water, the fuel ratio is approximately 15. Even multiple-effect plants operating between the same limits result in relatively poor fuel economy.

Unusually high fuel ratios can be obtained, however, by using low-pressure bleed steam to operate independent vacuum-type distilling plants, as illustrated in Figs. 2 and 3, or by making use of a "reducing-valve" evaporator. The term, "reducing-valve" evaporator, has usually been used to designate only those units which actually replace a reducing valve.

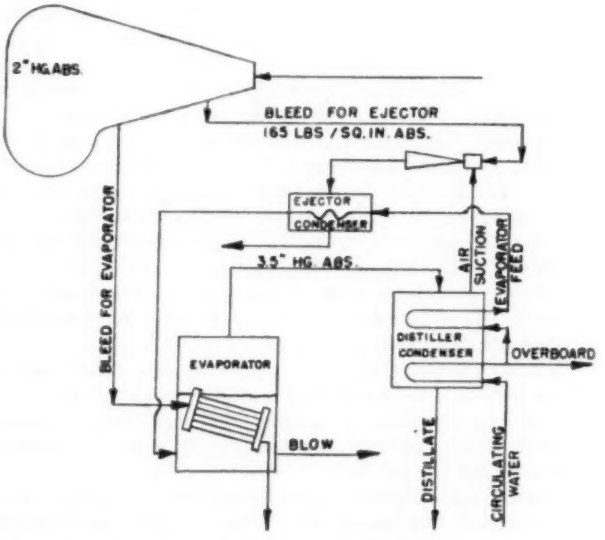


FIG. 2 TYPICAL SINGLE-EFFECT LOW-PRESSURE DISTILLING PLANT

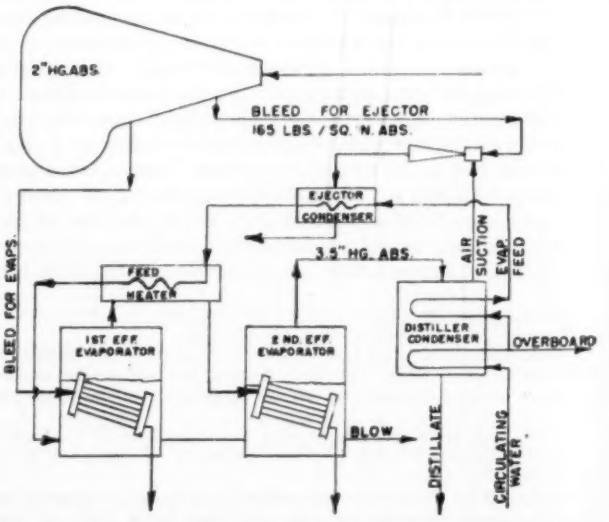


FIG. 3 TYPICAL TWO-EFFECT LOW-PRESSURE DISTILLING PLANT

i.e., where steam at a given pressure is condensed in the evaporator, and the evaporator vapor at a lower pressure is then utilized in some industrial process. It is proposed here to use the term in a broader sense so as to include any evaporator so tied in with other plant operations that the lower-pressure evaporator vapor

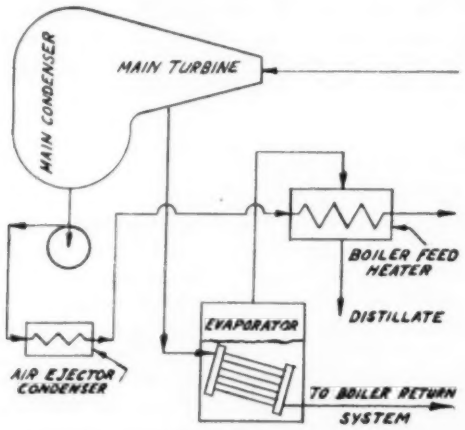


FIG. 4 REDUCING-VALVE TYPE EVAPORATOR FOR STEAM POWER PLANTS

is returned to the system to take the place of the steam used by the evaporator. Thus evaporators used in series with bleeder heaters in power plants (illustrated in Fig. 4) will fall in this general classification.

In order to analyze the performance of "reducing-valve" evaporators and low-temperature distilling plants operated by bleed steam, turbine performance must be known. Fig. 5 indicates approximately the amount of heat per pound of steam converted into mechanical energy in expanding from an initial pressure of 1200 psia, and a total temperature of 950 F, to a final pressure of 2 in. Hg abs. A turbine engine efficiency of 80 per cent has been assumed.

A total of 458 Btu per lb are converted into mechanical energy in the complete expansion. If the steam is bled from the turbine at 10 psia, 344 Btu are converted into work, a reduction of 114 Btu. This means that the increase in steam to be produced at the boiler is only (114/458) or 0.249 lb for every pound bled in order to maintain the same turbine energy output. If the condensate from the bled steam is returned to the boiler-feed circuit with only 10 deg subcooling, it will be at a temperature of 183 F instead of the 101 F in the main condenser, and it is fair to reduce the 0.249 lb slightly to compensate for the higher drain temperature. The equivalent is found to be actually about 0.23 lb. In a similar manner, the equivalent increase at the boiler per pound of steam bled at any point can be determined.

INDEPENDENT LOW-PRESSURE PLANTS

In the low-pressure distilling plants shown diagrammatically in Figs. 2 and 3, steam is bled from the turbine at about 165 psia to operate the air ejector (and any necessary pumps), and from a lower pressure to supply the necessary heat for evaporation. From the distilling-plant heat balance, the amount of steam to be bled at each of these points per pound of distillate may be determined. These values may then be converted to their equivalents at the boiler by the application of proper factors. The amount of fuel required to produce this additional steam at the boiler, and to supply also the further additional steam to preheat it in accordance with the appropriate power-plant heat balance, then may be determined.

Fig. 6 shows the results of such calculations for three typical power plants. This chart is based upon the following conditions:

(*a*) Initial steam conditions at turbine throttle:
Curve 1 415 psia, total temperature = 700 F
Curve 2 615 psia, total temperature = 900 F
Curve 3 1200 psia, total temperature = 950 F
(*b*) Turbine exhaust = 2 in. Hg abs
(*c*) Engine efficiency of turbine = 80 per cent
(*d*) Heat value of fuel = 18,500 Btu per lb
(*e*) Boiler efficiency = 85 per cent
(*f*) Allowance has been made for steam required to operate the distilling-plant air ejector, to power the necessary pumps, and to make up all heat losses.
(*g*) Steam condensate from the air-ejector condenser and from the first-effect tube nest is returned to the boiler-feed circuit at a temperature reasonably close to saturation.
(*h*) Allowance has been made for blowdown at the rate of 200 per cent of the distilling-plant output. This high rate of blow is desirable in sea-water plants. In fresh-water plants,

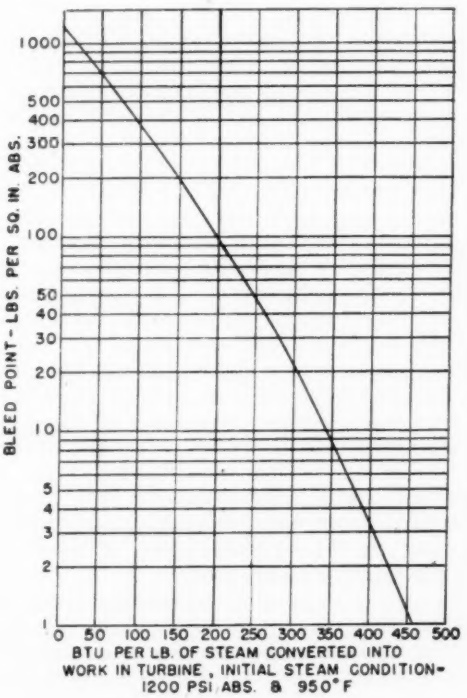


FIG. 5 APPROXIMATE BTU PER POUND STEAM CONVERTED TO WORK
(Expansion from 1200 psia and 950 F.)

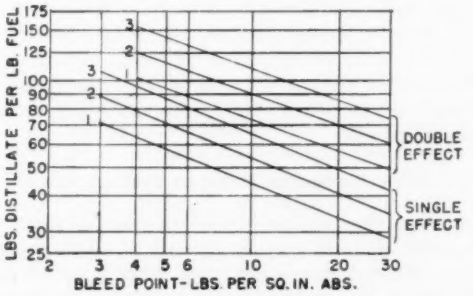


FIG. 6 FUEL ECONOMY OF LOW-PRESSURE BLEED STEAM-HEATED PLANTS

where the amount of blow can be reduced, the fuel economy will be increased by about 5 to 10 per cent.

REDUCING-VALVE EVAPORATORS

The fuel economy of "reducing-valve" evaporators, used in series with bleeder heaters, can also be determined by making use of Fig. 5. Consider, for example, a single-effect distilling plant heated by bleed steam at 20 psia and delivering vapor at 10 psia to a boiler-feed heater. Assuming the evaporator produces 0.90 lb of distillate per pound of steam (higher values may be obtained by preheating the feed by means of the blow and the distillate), it is necessary to bleed 1.11 lb of steam per pound of distillate. Each pound bled at 20 psia is equivalent to (153/458) or 0.334 lb at the turbine inlet, and therefore the flow through the turbine must be increased by 0.334×1.11 or 0.372 lb for every pound of distillate. However, 1.02 lb of steam would have to be bled at 10 psia in any event in order to accomplish the same amount of boiler-feed heating obtained per pound of distillate. This would be equivalent to $1.02 \times (114/458)$ or 0.254 lb of steam at the turbine inlet per pound of distillate. Furthermore, the 1.02 lb would be returned to the system at about 190 F instead of about 220 F actual drain temperature from the evaporator heating element. An additional flow of 0.01 lb would be required through the turbine to compensate for this difference in drain temperatures. Thus the net increase in steam flow through the turbine per pound of distillate is only $0.371 - (0.254 + 0.01)$ or 0.107 lb. Depending upon the particular power plant involved, the amount of fuel oil necessary to generate this greater amount of steam will be between 0.0075 and 0.0092 lb; thus the fuel-economy ratio is between 110 and 132 lb of distillate per pound of fuel. By a similar process, an evaporator supplied with steam bled at 5 psig and returning vapor at 0 psig to a boiler-feedwater heater will be found to have a fuel ratio between 165 and 190.

The fuel-economy ratio increases as the difference in pressure between the bleed point and the evaporator vapor is reduced. At the same time, however, the amount of evaporator heat-transfer surface required for a given output also increases very rapidly. From the standpoint of distilling-plant economy alone, the optimum pressure difference must be found by balancing the reduction in fuel costs against the resulting increase in fixed costs. In existing power plants of course other factors may also require consideration.

There is little of a general nature that can be said about reducing-valve evaporators providing steam for industrial processes. If the steam is bled at a higher pressure because of the existence of the evaporator, the fuel ratio may be determined in the same manner as for the reducing-valve evaporator used in series with a bleeder beater. If, however, the evaporator actually takes the place of a reducing valve in supplying reduced-pressure steam for some industrial process, the fuel ratio depends upon the additional heat required at the boiler to make up the difference between the steam that would have been delivered by the reducing valve and that which is actually produced in the evaporator for the same input. These fuel ratios will generally be higher than those for reducing-valve-type evaporators used in power plants since there is no power loss to be considered.

RELATIVE PERFORMANCE OF VARIOUS TYPES

In some cases the question of relative over-all economy of the various types of units may be entirely academic because the conditions imposed may make some other criterion more important. Thus, the military may consider mobility more important than economy, or space considerations may dictate a single-effect plant where a double-effect plant might prove more economical, etc. The following general observations, however, are usually applicable:

1 Heat losses from radiation, venting, brine discharge, etc., are of critical importance in the case of compression-type units but only of minor importance in most steam-heated units, and negligible in the case of low-pressure independent plants. Thus an increase in these losses of 20 Btu per lb of distillate over those upon which the fuel ratios previously given were based would reduce fuel economy as follows:

	Per cent
Electrically driven compression unit	22
"Reducing-valve" evaporator	7
Low-pressure independent plant	2

2 Because of the negligible effect of heat losses, low-pressure independent plants are especially suitable for use where the quality of the raw water is such as to require a large amount of continuous brine discharge. With sea water, for example, good practice requires a blowdown rate of 200 per cent of the distillate to minimize scale formation. The fuel ratios given for compression-type units were based upon a blowdown rate of only 25 per cent. An increase to 200 per cent would require an enormous feed heat exchanger in order to maintain the same brine-outlet-feed inlet temperature difference, and even then would result in a reduction of about 35 per cent in the fuel ratio. The fuel ratios given in Fig. 6 for low-pressure plants are already based upon a blowdown rate of 200 per cent and no brine-feed heat exchanger whatever is required.

3 Steam-heated plants are generally simpler to operate than vapor-compression-type units. Heat input and heat output automatically balance themselves in steam units whereas it is necessary to achieve this balance by regulating the amount of auxiliary heat supply, or by regulating the amount of brine discharge in the compression-type units. Control of water levels, etc., can be made automatic in both types.

4 In most cases, both the initial and maintenance costs of compression-type units for a given capacity will be greater than those of steam units. A large part of these charges can be attributed to the compressor.

5 Scale formation is practically eliminated by low-pressure low-temperature distillation. When the heating steam temperature does not exceed 160 F and evaporation takes place at 125 F or less, operation with untreated feed for a year or more without cleaning is quite possible. At present, such low-temperature distillation is not practical with compression-type units because the size and cost of vapor compressors increase prohibitively as the suction pressure is reduced. Future advances in steam-compressor performance may remove this disadvantage.

6 Good fuel economy can be obtained in the vapor-type compression units with very low temperature differences. At the same temperature difference, the single-effect low-pressure bleed-steam-heated plant yields about the same fuel economy as the engine-driven compression-type unit, while the 2-effect low-pressure plant and reducing-valve evaporators give better results.

7 The cost of engine fuels is considerably higher than that of boiler fuels. This may make the internal-combustion-engine-driven compression-type unit the least economical when the other alternatives are possible.

8 Vapor-compression-type units appear to be economical only in cases where distillation must be accomplished entirely independently of a steam power plant or other steam installation. If there is a cheap source of electricity available, the electrical drive should prove advantageous. The engine-driven compression-type unit is particularly useful where great mobility is desirable.

NEW STANDARD SURFACE-ROUGHNESS SPECIMENS, DEPICTING 10 DEG OF ROUGHNESS WITH A TOTAL OF 25 DIFFERENT FINISHES

Determining SURFACE ROUGHNESS

By WALTER MIKELSON

GENERAL ENGINEERING AND CONSULTING LABORATORY, GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

HOW to select, specify, and obtain desired surface finishes for machine-tool work is a far more difficult problem than is generally realized. What kind of a surface can be expected on a finished product when the specifications on the drawing simply say grind? Experience shows that the roughness of resulting finishes, that is, the average depth of surface irregularities, may vary almost 10 to 1. What kind of a surface can be expected when the specifications contain complicated instructions covering the type of machine tool to be used, grit size, speed of operation, and so on? Experience shows that the resulting finishes may vary as much as 4 to 1. On the other hand, where the specifications identify the finish by a symbol, referring to a sample block, much closer control is possible; variation seldom exceeds 2 to 1.

PRACTICAL METHOD DEVELOPED FOR GAGING ROUGHNESS

Various instruments such as the profilometer and the surface analyzer are available to measure surface roughness. Comparator microscopes permit detailed observation and comparison of surfaces, but do not actually measure roughness. These and other instruments are valuable for many purposes, but we have found they are not practical for general use in manufacturing operations where determination of surface roughness must be made quickly at frequent intervals. What is needed is a convenient method by which (1) the design engineer can select and specify the degree of roughness required, (2) the machine-tool operator can compare the result of his work with the specification, and (3) the inspector can check the finished product when the machining has been completed.

About 15 years ago, the author's company first tried to develop a simple and practical method of specifying and checking surface roughness. The method adopted in the beginning involved the use of sample specimens of the actual work. These were first approved by the design group and then distributed in the shop. Where a product consisted of a number of parts, or where a shop produced a variety of products, the quantity of sample specimens needed was inconveniently large. As changes were made in design and new products added to the list of established products, the stock specimens became extremely unwieldy.

In an endeavor to reduce the stock samples and to simplify the procedure generally, a standard set of representative samples was prepared, depicting typical finishes arranged in orderly steps of roughness. Under this plan, which has now come into widespread use, the first step is for the design engineer to select from his set of specimens the proper finish for each piece of work. This finish is then specified by symbol on the drawing. The production department interprets the finish required with the aid of a duplicate set of samples. Finally, the inspector checks the work by comparison with a third set. In this procedure all comparisons are made simply by sight-and-feel

Based on paper contributed by the Production Engineering Division and presented at the Annual Meeting, New York, N. Y., December 2–6, 1946, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

STANDARD ROUGHNESS SPECIMENS USED BY DRAFTSWOMAN AND ENGINEER TO SELECT TYPE OF FINISH TO USE ON A SURFACE

methods. The use of measuring instruments has been found to be necessary only in exceptional cases.

The design engineer specifies only the degree of roughness required and not the method by which it is to be obtained. This is done because it is felt that ordinarily the production engineer, familiar with the factory work loads and the equipment available, is in a better position to select the quickest and cheapest method of processing this product.

To cover the full range of roughness attainable with present-day machining and other methods, a set of specimens must include samples varying in degree of roughness from a smooth lapped, honed, or ground surface, to a rough-milled shaped, sawed, or gas-cut surface. The set must also be divided into intermediate steps frequent enough to permit the selection of a satisfactory roughness and not so frequent as to surpass personal ability to distinguish between adjacent degrees of roughness by sight and feel.

ABILITY TO JUDGE ROUGHNESS

Tests conducted within the author's company of the ability of reasonably experienced inspectors and production men, have indicated that 4 microinches average is the limit below which roughness cannot be judged satisfactorily. Visual and tactual selections made on various degrees of roughness below this point become confused and inconsistent. There seems to be no upper limit of roughness where a similar limitation applies. These investigations have also led to the conclusion that specimens above 4 microinches which vary in two-to-one steps of roughness can be quite consistently distinguished, provided that they are specimens made by the same or similar methods of machining.

Since surfaces processed by different methods have different appearances, even though the depth of the irregularities may be the same, it is considered necessary, particularly for the intermediate and rougher finishes, to provide several samples of

ROUGHNESS VALUES OF STANDARD SPECIMENS

Symbol	General Electric symbol	Roughness, microinches: Average[a]	Roughness, microinches: Average peak-to-valley[b]	Typical methods of producing (There are additional methods not listed here)
A	f^1	4	15	Ground, lapped, honed, microhoned, superfinished, etc.
B	f^2	8	28	Ground, lapped, honed, microhoned, superfinished, molded, drawn, etc.
C	f^3	16	56	Ground, lapped, honed, reamed, scraped, superfinished, bored, burnished, planished, milled, molded, precision-cast, cold-pressed, drawn, extruded, etc.
D	$f^{3\,1/2}$	32	118	Ground, broached, reamed, scraped, turned, bored, burnished, milled, planished, molded, precision-cast, cold-pressed, drawn, extruded, etc.
E	f^4	63	220	Ground, broached, rolled, shaped, turned, bored, milled, abrasive cutoff, reamed, molded, precision-cast, extruded, drawn, etc.
F	f^5	125	455	Ground, broached, rolled, reamed, shaped, turned, bored, milled, drilled, spot-faced, counterbored, filed, punched, abrasive cutoff, molded, precision-cast, extruded, forged, etc.
G	f^6	250	875	Ground, rolled, shaped, turned, bored, milled, drilled spot-faced, counterbored, filed, punched, sand-cast, forged, precision-cast, etc.
H	$f^{6\,1/2}$	500	1750	Ground, gas-cut, chipped, shaped, turned, bored, milled, sawed, filed, punched, sand-cast, forged, etc.
J	f^7	1000	3500	Ground, gas-cut, chipped, shaped, turned, bored, milled, sawed, sheared, nibbled, welded, punched, sand-cast, forged, etc.
K	f^8	2000	7000	Gas-cut, chipped, shaped, turned, milled, sawed, sheared, nibbled, welded, parting cut, sand-cast, etc.

[a] Determined by a profilometer or calculated.
[b] Determined by a surface analyzer, a profile recorder, or calculated.

each specific degree of roughness to indicate the differences in appearance and feel which might normally be encountered, using typical methods of processing. For the rougher finishes, the maximum number of samples required to represent any single degree of roughness seldom exceeds four. For the finer finishes, one or two is sufficient.

SAMPLE ROUGHNESS SPECIMENS

The set of sample specimens developed by the company consists of ten metal blocks, each $2 \times 2^1/_2$ in., fitted into a box for protection and convenient handling. Each block is identified by a letter and represents a certain degree of roughness. An accompanying table shows the roughness value of each block as measured by a profilometer and by a surface analyzer. Several of the blocks are subdivided into two or four different surfaces to show finishes of the same degree of roughness, but made by different types of machines. Any of the sample blocks can be removed from the box easily and held close alongside a machined surface for comparison of the degree of roughness.

PRODUCING ROUGHNESS SAMPLES BY ELECTROPLATING

Before the war the company produced specimens for its own use by machining each block individually. This was an expensive and time-consuming process. With the advent of the National Defense program the need for sets of specimens was greatly augmented. A request by Army Ordnance for a large number of sets could not be filled because the company's precision equipment was busy on other work and personnel was not available to machine individually each of the thousands of specimens needed.

This request, however, prompted the company to explore means of reproducing specimens from an accurately machined master plate. Various methods and materials for producing replicas were suggested and tried, and a lengthy investigation was made in the company's laboratory to study accuracy of reproduction, uniformity of appearance, and cost. These investigations led finally to the selection of an electroplating method. Our experiments, later confirmed by others, indicated that the accuracy of reproduction possible was within 2 or 3 per cent, which is better than the accuracy of commercially available instruments for measuring surface roughness.

The electroplate process we use in manufacturing is similar to that used in the printing industry. A thin lead plate is pressed into the master surface to produce a negative impression on the lead plate. It is then pulled away from the master and a thin coat of nickel (0.003 to 0.005 in.) is electrodeposited on the lead impression. A coat of copper (0.010 to 0.015 in.) is next electrodeposited over the nickel to provide backing. The combined coats of plating are pulled loose from the lead, yielding a positive imprint of the original master on the surface of the nickel. This sheet of nickel and copper plating is then backed with additional material for rigidity.

MASTER PLATE CHECKED CAREFULLY

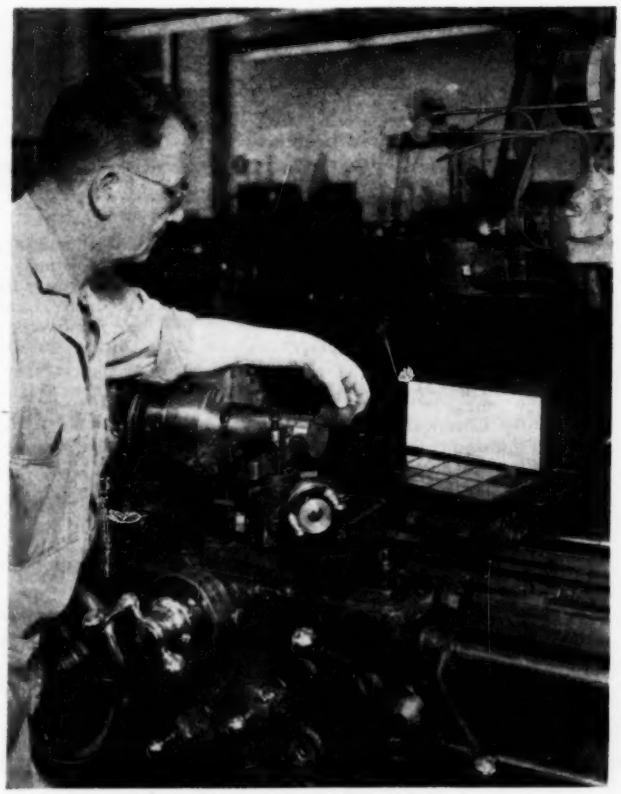
Several makes of instruments are used as independent checks of roughness during preparation of the master plate. Smooth samples are measured both by the profilometer and the surface analyzer. Where the range of these instruments is exceeded on the rougher specimens, a profile curve is plotted by a General Electric profile recorder, and the average roughness value of the profile calculated by dividing the peak-to-valley height by a factor of 3.5. Studies of this ratio seem to indicate that for smooth surfaces the ratio may be considerably higher, but for rough surfaces where the profile is relatively simple, the factor of 3.5 is approximately correct.

Although the tolerance permitted in the preparation of the master is very small and reproductions are faithful to ± 2 or 3 per cent of the master, the guaranteed accuracy is —25, + 10 per cent of the nominal designated value. Most of this is safety factor to account for such items as point-to-point variations on the surface, uncertainties in commercial instruments used here and which may be used by others to check these specimens. Most commercial instruments of any one type can be depended upon to agree with each other within an accuracy of ± 15 per cent. Under careful experienced operation and with frequent standardization of calibration these same instruments will vary between ± 5 and 10 per cent.

SUPPLEMENTARY SPECIMENS SOMETIMES REQUIRED

Supplementary specimens have from time to time been requested by certain groups within the company. These have included cylindrical specimens, flame-cut, and sandblasted specimens. Samples are made and used for a short while but the trend in most cases seemed to drift back to the original flat set. Supplementary specimens, when made, are prepared and checked to correspond to the degrees of roughness provided in the standard set and the same method of specification and procedure of selection is used.

Use of the standard roughness specimens was tremendously accelerated by the war. They were widely employed in the aircraft, automotive, and electrical industries, as well as by Army Ordnance. The author's company furnished sets for a substantial part of the hundreds of subcontractors working with the company. Results cannot be exactly evaluated in dollars and cents, but there is no question but that their use contributed greatly to obtaining interchangeable and uniform surface finishes at minimum expense.



MACHINIST USING STANDARD ROUGHNESS SPECIMENS TO CHECK FINISH ON WORK IN LATHE

Practical Aspects of Design of STRUCTURAL-RUBBER PRODUCTS

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THE term "structural rubber" is used in this paper to designate those classes of elastic materials, natural or synthetic, which are applied primarily to isolate resiliently, to transmit, or to support various types of loads or forces. The term further implies that materials of this class have known useful and predictable engineering properties.

Common articles utilizing rubber in this category include motor mountings, instrument isolators, vibration dampers or absorbers, couplings, shock bumpers, bushings, and bearings. As is immediately apparent, most structural parts are rubber-and-metal assemblies of the adhered type. Since the adhered or "bonded" rubber-metal parts comprise the largest portion of products in this field, discussion will be limited to that type unless specifically stated otherwise.

REVIEW OF DESIGN AND MATERIAL FACTORS

A general outline of typical items which must be considered is shown in Table 1. While this outline is by no means complete in so far as every conceivable material property or performance condition encountered is concerned, it covers most common problems and it will serve for purposes of general study.

TABLE 1 COMMON FUNCTIONAL AND MATERIAL DESIGN FACTORS OF ADHERED RUBBER-METAL PRODUCTS

I Functional factors	II Secondary or hazard factors (Surrounding media and conditions)	III Inherent rubber property factors
(*A*) Structural use types 1 Vibration insulation or isolation (*A*) Mechanical (low frequency) (*B*) Audio (high frequency) 2 Shock or impact absorption 3 Vibration absorption or damping 4 Resilient couplings 5 Resilient bushings or bearings (*B*) Nonstructural-use types 1 Sealing (*A*) Gaseous (*B*) Liquid (*C*) Solid (aggregates, etc.) 2 Protective covering (*A*) Physical (abrasion, scuffing, etc.) (*B*) Chemical 3 Frictional control 4 Electrical effects (*A*) Dielectric (*B*) Conducting	(*A*) Heat sources or temperature changes (*B*) Rubber deteriorants 1 Oils, greases, solvents, etc. 2 Gases, oxygen, ozone, etc. 3 Rays, sunlight (ultraviolet), etc. 4 Cut, tear, or chipping-producing effects (*C*) Metal deteriorants 1 Moisture 2 Corrosive fluids or electrolytes 3 Corrosive gases 4 Abrasives	(*A*) Modulus-tension, compression, and shear 1 Static 2 Dynamic (*B*) Tensile and elongation (*C*) Bond-stress limits (*D*) Fatigue characteristics 1 Static 2 Dynamic (*E*) Creep or set (*F*) Hysteresis (*G*) Abrasion resistance (*H*) Tear and cut growth resistance (*I*) Temperature effects on properties (*J*) Aging characteristics; resistance to heat, light, and atmospheric attack (*K*) Resistance to oils, greases, solvents, etc. (*L*) Resistance to unusual chemical deteriorants

Section I-A lists several of the more familiar functions for which structural rubber may be used. These application factors may be involved singly or in combination and are readily recognized in the fundamental problem and part design particularly in so far as theoretical treatment is concerned.

Section I-B shows various application types which are generally not considered as "structural" and are rarely approached from a theoretical analysis viewpoint. However, they occur frequently in combination with the nominal structural-application factors and may have considerable influence on final design.

Section II lists factors or conditions external to the part which are considered as deteriorating or which will affect physical properties. Frequently, these can be minimized by design treatment as well as material selection.

Section III lists those factors which express principal basic material and chemical properties of a rubber compound. These cannot be modified by design, being fundamental material characteristics for each type of compound; however, their effects can be best utilized, or minimized if detrimental, by both theoretical and practical treatments. An examination of this outline, particularly by the less experienced, may readily reveal factors which are easily overlooked in various problems. This outline, or a similar one, will serve as a check list to prevent omission in design work.

In the discussion following, such items as are considered are not presented in the categorical sequence given in the outline, but as to importance and sequence normal to design procedure.

METAL-ANALYSES, MANUFACTURING PROCESSES, AND ATTACHMENTS

For many years low-carbon, full-pickled, hot-rolled steel was the principal metal used for structural parts. This was adopted since the material was compatible with early-production brass-plate adhesion processes and was procurable, in the market, with the degree of uniformity required for high-grade work. However, the increase of brass-plating-processing knowledge, and the development of other adhesion processes have produced a degree of versatility which will permit procuring high-quality

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bond between natural or synthetic rubber compounds and a wide selection of metal alloys. A wide range of steels, brasses, bronzes, and aluminum alloys permits application of rubber-to-metal structures. However, some of the synthetics and present production adhesion processes are also not compatible with certain metal alloys. Therefore it is advisable to discuss new rubber-metal combinations with the rubber manufacturer, although production compatibility will be found in a large percentage of typical cases.

The various metal casting, forming, or machining process types commonly used for metal production will produce satisfactory adhesion surfaces, provided that a reasonable degree of surface uniformity, smoothness, and cleanliness is maintained. Fabrication of the metal components or assembly of the finished part demands consideration of such elements as welding or brazing processes; integral bolts and nuts; machining for splines; and press fits.

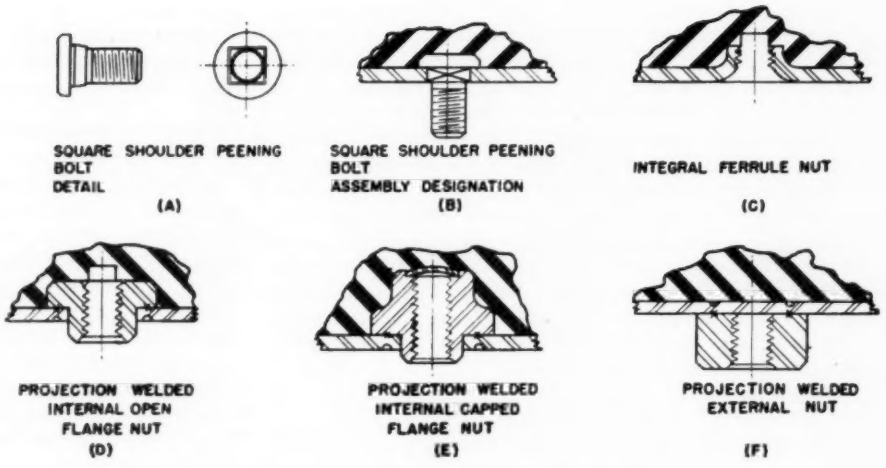

FIG. 1 MOUNTING ATTACHING ELEMENTS

Welding and brazing processes are used extensively in the fabrication of metals prior to molding. Principles to be observed are that the welds must be sound and free from pits or inclusions and must be readily cleaned by either sandblasting or appropriate pickling operations.

Welded joints and the component arrangement should be so accomplished that fluxes, oils, cleaning or plating solutions, or grit-cleaning particles will not be trapped. This is particularly vital at or near the adhesion surfaces where such trapping may prevent proper cleaning or plating and further contaminate the treated surface by a bleeding action. Lap welds or similar joints which use partial or interrupted beading are particularly bad in the respects mentioned. Copper furnace-brazing generally produces a satisfactory joint since it is filled by the brazing material. The use of excess brazing metal at the joint, or flow around it, should be avoided since high-copper alloys are not highly compatible with all adhesion processes.

Welding processes are not recommended for attaching cured-rubber-metal parts to mating parts or assemblies since heat produced may injure the rubber. Occasionally, metal extension beyond the rubber is sufficient to permit proper temperature protection of the rubber through water cooling or high thermal capacity of the metal, or by use of processes evolving a minimum of heat. Such practices should be released only after experimental work produces test approvals on actual parts.

Integral bolts or nuts, as well as separate bolts or rivets, are the most common means of attachment. Of the integral-bolt designs, the square-shoulder peened type is popularly used. An example is shown in Fig. 1 (*A*). The bolt is designed with a square tapered shoulder, which permits a piloted prepositioning, and with sufficient shoulder length to provide material for upsetting or peening-in the mating metal. The upsetting operation provides a tight joint which prevents escape of rubber at this point during molding. This is important since thread-fouling and costly cleaning operations are avoided. The square shoulder prevents turning during assembly. This bolt type is currently used for thread sizes from $^3/_{16}$ in. diam. to $^5/_8$ in. diam. and for metal thicknesses of $^1/_{16}$ in. to $^1/_4$ in. These bolts can be produced readily by standard upsetting methods, and from low-carbon-quality to heat-treated quality steels similar to those used in standard bolts.

Attachments requiring threaded sections which must be incorporated into the metal components are shown in Fig. 1 (*C*, *D*, *E*, and *F*). These are employed when integral bolts or separate nuts are not applicable. Type (*C*) is a low-cost element but has objectionable features due to stress concentrations and limited thread strength, particularly on thin metals. This type also requires insertion of a threaded pin in molding to keep out the rubber, the use of which represents a considerable cost element. Since rubber can be forced into the thread clearances during molding, a thread-chasing operation is necessary on a percentage basis. Type (*D*) is used where a flush nut, embedded in the rubber is necessary. It is a rugged type, although costly. The principal objections are to high stress concentration involved if rubber sections are thin and the necessity for protecting and cleaning threads. Type (*E*) is a more costly element than (*D*) but complete thread protection is provided, eliminating process-protection costs. It is objectionable from a stress-concentration viewpoint in some cases. Type (*F*) is used to provide thread closure and avoid stress concentration. It does take more space and is not structurally as safe as (*D*) or (*E*), although proper welding will produce surprising resistance to tension, shear, or bending forces. A 5000-lb minimum tensile test is commonly met in 1-in-OD stock welded to $^1/_8$-in. metal.

Close tolerances on metal details such as are required for precision pilots, press fits, and splines are frequently difficult to maintain if these dimensions are "finished" prior to molding, particularly on fragile metals. One of the common metal-design defects is the inability of metal components to resist the large crushing or bursting forces caused by the molding pressures involved, combined with the operational cost or impracticability of supporting the metal completely. Not only is maintenance of tolerance a question, but some materials do not have sufficient elasticity to permit deformations to "take up" metal tolerances and mold clearances, without breakage, to the point where the mold can provide full support.

Unit cavity rubber pressures of 5000 psi are quite common and occasionally the figure may be as large as 10,000 to 15,000 psi. It is advisable to use the latter figure for a rough check on the effects of molding pressures on nonplanar metals. The importance of considering the effects of these forces on metals cannot be overemphasized.

The flash-removal problem is also frequently such as to make a difficult operation (as in cleaning internal splines), or the metal finish may be damaged by brushing or scraping operations. To avoid the difficulties mentioned, the procedure of

machining after molding is often used. Centerless-grinding, lathe-machining, sizing, broaching, and drilling or reaming are commonly practiced. In selecting a process, some thought must be given to its effects on the rubber, particularly as to heat or lubricant. Soluble oil-water coolants used on grinding and heavy or high-speed machining operations are generally satisfactory for removal of heat without serious effects on the rubber, if properly handled. All lubricants should be removed, particularly on natural rubber or GR-S, immediately after processing, by a suitable method which will not cause deterioration or form residual active materials such as alkaline salts. Machining practices which require cutting through the metal into the rubber are also to be avoided, since incipient tears, heat effects, and stress concentrations from burrs and sharp edges are practically always present.

SIZE, WEIGHT, AND SHAPE FACTORS

Production limits must be recognized in designing a part as to its size, weight, and shape. For example, it is generally unfavorable, from a quality and cost viewpoint, to design quantity-production items with a net rubber-section thickness in excess of 2 in., unless intermediate mold or metal component members provide excellent heat conductivity. The reason for such a limit is that the poor heat conductivity of rubber compounds results in an extremely long cure, with high-burden costs, and may further cause a lack of uniformity of cure with resultant reduction in quality. Individual problems may require exception to the rule, particularly on small production items, but they should be considered only after proper consultation. The length and width factors are much more expansive.

One of the basic cost principles involved in economical quantity production is that the minimum amount of metal necessary to the final part assembly be brought through the rubber-manufacturing processes even though additional subassemblies may be required. The design of parts involving use of a great portion of metal with respect to the rubber, so as to produce "unit" constructions, increases handling costs and results in a lower quantity yield from various high-burden processing equipment. Unavoidable additional operations may also be involved for protection in process or flash-removal operations.

Parts should be designed so that the major attachment bases will be principally on the base assembly unit rather than on the rubber-metal components. A part may also be broken up into several components and manufactured and assembled more economically as compared to a single large section.

Shape factors should be observed in the same manner applicable to castings, or forgings. Undercuts or re-entrant curves on the draft edges, counterbores, coring, and the like, should be avoided whenever possible since the use of cores or loose bars is required in the mold with corresponding increase in cost of equipment and piece price.

Weight factors are important in manufacturing since a large amount of manual handling is required through the processes. In general, part weights up to approximately 15 lb are readily handled; between 15 and 25 lb handling becomes more difficult, and in excess of 25 lb special handling or processing is a practical must, which of course increases costs out of proportion to the increased weight.

ADHESION CONSIDERATIONS—FATIGUE AND CORROSION IN BOND REGIONS

One of the problem factors given previously, and which is subject to considerable misunderstanding and controversy, is the general subject of adhesion. Much criticism has been leveled at the rubber industry because of the fact that there is no universal standard for recommended static or dynamic bond stresses except for a few specialized types of applications. While this situation cannot be examined at length, the considerations discussed will show that a number of factors are involved in the adhesion problem, and that procurement of guaranteed high ultimate bond strength and use of categorically recommended safe bond stresses are not alone a sufficient answer to the problem.

Strictly speaking, low ultimate bond-stress values are not the underlying cause in most so-called adhesion failures. An examination of many failed parts and their operating history has indicated that factors frequently contributing are as follows: Stress concentrations from poor metal or rubber design; metallic corrosion at the bonding layer; mechanical injury; deterioration of the rubber by various light rays, gases, solvents, or oils; and static[1] or dynamic[2] fatigue of the rubber; although casual examination may indicate otherwise. Failure often starts from one or more of these causes and then a gradual flex-tearing and bond deterioration progresses along the adhesion face. Assuming that the best material has been selected for a given job and proper design analysis has been made, then some corrective factors available to the designer are (1) use of metals having proper adhesion face characteristics and freedom from sharp edges, burrs, or other stress raisers; (2) use of fillets, and

[1] "Static Fatigue Life of Rubber," by S. M. Cadwell, R. A. Merrill, C. M. Sloman, and F. L. Yost, *S.A.E. Journal* (Transactions Section), vol. 49, 1941, pp. 442–447.

[2] "Dynamic Fatigue of Rubber," by S. M. Cadwell, R. A. Merrill, C. M. Sloman, and F. L. Yost, *Industrial and Engineering Chemistry*, Analytical Edition, vol. 12, 1940, pp. 19–23.

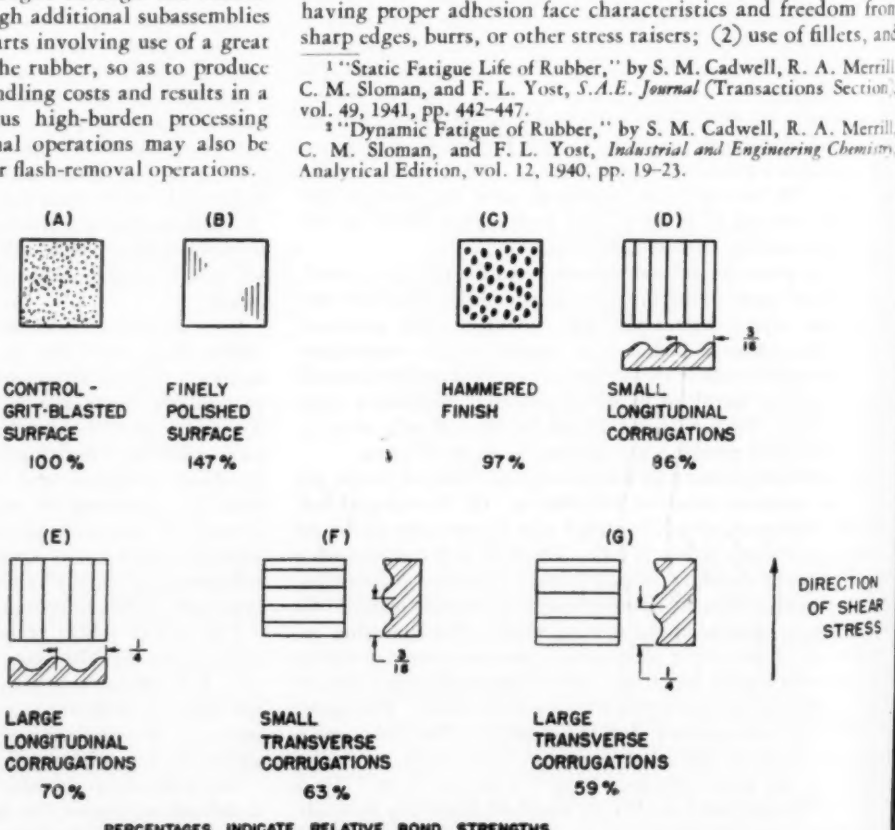

FIG. 2 EFFECTS OF METAL-SURFACE CHARACTERISTICS ON ULTIMATE SHEAR-BOND STRENGTH

precompression where practicable, to reduce stress concentration at the rubber margins and to resist various corrosion hazards.

The characteristics of the adhesion surfaces have important effects on both processing and performance. Regardless of the process used for adhesion, uniformity of treatment is paramount, and this requires relatively smooth continuous surfaces for this purpose. This same type of surface also produces the high bond strengths for the direct adhesion of flexible rubber to metal. This is contrary to the common assumption that knurled patterns, corrugations, serrations, undercuts, and holes will improve bond performance.

Fig. 2 shows some results demonstrating these points by comparing surface effects on ultimate bond strength through use of various surface treatments. The same type of metal, adhesion method, and compound were used in all tests. The values shown are the relative average unit-shear bond loading determined by using the stressed area as that projected on a plane parallel to the face of the metal. The shear force was applied in the direction shown by the arrow. The relative percentual bond-strength rating of each type of surface is shown below each figure. These data demonstrate the futility of using expensive corrugating operations to improve bond strength. Other tests utilizing sharp-edged saw-tooth types of serrations for the bonding surface have shown even more drastic reductions in bond strength, as may be expected. While the specific bond values will vary with compound type and shape factors, these tests, nevertheless, serve to indicate the general effect of surface roughening or ribbing to increase bond strength.

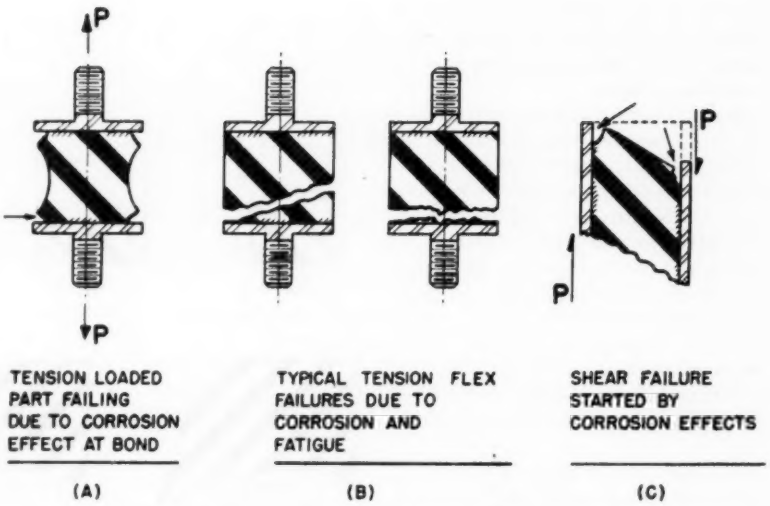

FIG. 3 TYPICAL "ADHESION" FAILURES DUE TO CORROSION OR FATIGUE, ACCELERATED BY STRESS CONCENTRATIONS

Bond strength can be improved as indicated by using finely polished metal surfaces, but such refinements are not necessary to obtain satisfactory results for general application. Finishes produced by smooth rolling, drawing, machining, and grinding operations are satisfactory, provided that embedded oxide or other slag inclusions, pits, folds, seams, and burrs are avoided. Smooth cast or forged surfaces are also acceptable, provided that protruding sprues or similar projections, flash fins, pits, or porosity, and other surface defects are not present. A sand-blasting or pickling operation is used to remove scales or oxide layers prior to adhesion processing. These latter processed types may also require machining on edges or surfaces involved in positioning or cavity-sealing at molding operations.

Deterioration of the bonding layer or adjacent rubber has also been traced in many cases to both metallic corrosion and rubber fatigue, and in most of these cases it is not easy to separate their effect. The rubber fatigue, static or dynamic, may further be due to stress or aging effects, or both. High-quality adhesion and use of proper rubber compound are of great importance, but proper design treatment can also improve their effects.

If an adhered part is strained in tension and subjected to corrosive condition such as from moisture or electrolyte-bearing solutions, the metallic components may deteriorate in such a manner that a progressive failure occurs in the adhered plane. This is illustrated in Fig. 3 (*A*). Further, if the part is flexed, stress concentrations can result in a tearing condition in the rubber which may also induce re-entrant failures at the adhesion plane. Stress concentration will also accelerate dynamic- as well as static-fatigue effects. Such continued exposure and stress concentration induces rapid corrosion of the bond or fatigue failure in the rubber. Conditions of this type are illustrated in Fig. 3 (*B*). This demonstrates one of the most important reasons as to why adhered rubber is rarely used in tension.

The foregoing tension effects also occur to some degree in shear loadings, as shown in Fig. 3 (*C*), since there is a tension component present, particularly at the ends of a parallel-plate design. Induced-tension effects occur to a lesser degree in compression, since the bond margin stress is generally lower and the type of strain tends to press the loose edges, which are considerably relieved of stress, down against the metal and produces some degree of protection.

The choice by the rubber manufacturer of an adhesion method such as the use of an organic bonding cement, as compared to brass-plating methods, is occasionally a solution to marginal problems, but this method is not as foolproof as it might first appear to be, since certain other chemical susceptibilities of the bond are involved. Similarly, the selection of corrosion-resisting metals may be partially helpful, but susceptibility of the adhesion layer to deteriorants is not eliminated entirely. Filleting and precompression, as mentioned, are the most common forms of stress or fatigue relief available to the designer and apply either to bond considerations or to rubber fatigue.

Fig. 4 shows various types of fillets which are commonly used to increase bond life. Detail (*A*) illustrates the familiar circular segment. This will produce protection from mild fatigue and corrosion effects and is most easily made as to economy of equipment and assembly space. The angular or buttress design of the rubber at the ends of shear sandwiches, such as shown in (*A*), (*B*), and (*C*), also serve to reduce induced tensile forces at these sections as well as to increase stability. Detail (*B*) illustrates a fillet which will produce nominal fatigue protection with increased protection against deteriorants which may migrate through the "toe" or tangent section of the common fillet. This fillet also offers resistance to mechanical action or injury from flying materials or debris which may crush through the toe sections.

Details (*C*) and (*D*) show further extensions of these principles. Detail (*C*) represents a special type of combining bond protection and stress relief, with a special stress-relief element required to reduce detrimental effects in the body section. Detail (*D*) accomplishes part of the fillet effect by metal modification. Detail (*D*) is generally costly to incorporate as based on metal manufacture, but may be most economical where operational factors, i.e., corrosion and fatigue, are severe.

Details (*E*) and (*F*) which fall in the class of "beads" are

actually modifications of filleting and sealing devices. These permit complete closure of the metal insert and mating attaching surfaces.

Detail (*G*) which is an extension of (*B*) or (*C*), is a more specialized element, and is used only underconditions of extreme stress-concentration or bond hazards. This particular element is incorporated into at least one patent design which is the Hile type bushing.[3] It is quite effective on such type parts where high radial compression, circumferential shear, and induced tension forces are encountered along with severe weathering and corrosion hazards on such applications as tractor-track bushings.

The addition of fillets generally involves increased mold and piece-price costs particularly where undercuts for filleting are required for this purpose alone. It should be noted, however, that invariably cost effects on piece price are in the less-than-10-per-cent category. Since life or material economies gained generally exceed 10 per cent, essentiality to the solution of a given problem can be used as the guiding factor without checking refined cost figures.

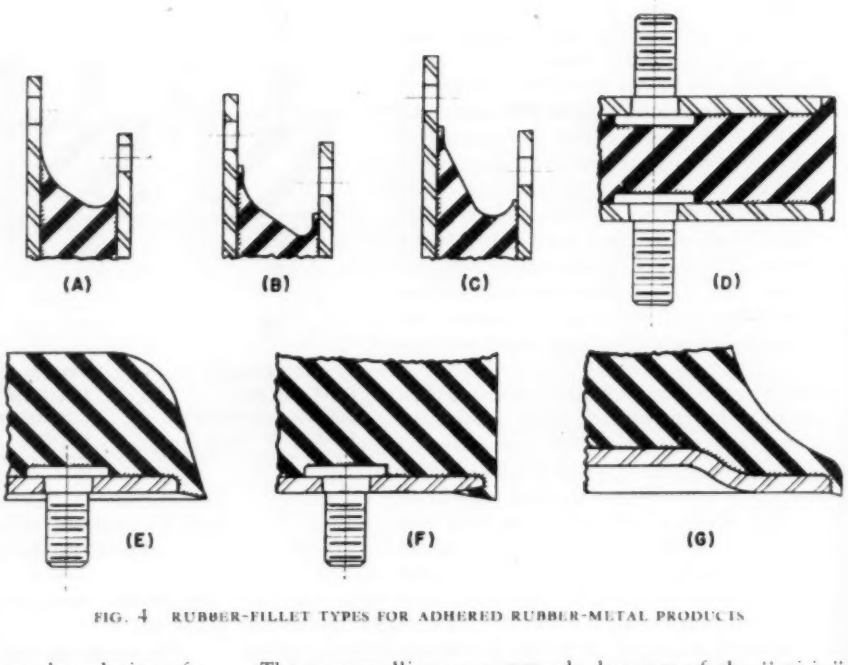

FIG. 4 RUBBER-FILLET TYPES FOR ADHERED RUBBER-METAL PRODUCTS

Flexible protective coatings are applied to structural-rubber parts as a means of reducing ill effects of common fluids, and occasionally gases and light rays. The most common uses of these coatings are for oil, grease, or solvent protection of natural-rubber or GR-S products. These are, basically, cements or lacquers made from elastomers such as neoprene or Buna "N" which have preferred characteristics in so far as resistance to the fluids mentioned is concerned. The materials are applied by spraying, dipping, or brushing processes after curing.

In evaluating the utility of coatings, it must be remembered that while this protective film may resist swelling or deteriorating action, it will absorb fluids to some degree. Therefore migration into the body of the part can occur. This rate of migration is dependent upon the fluid concentration or pressure as well as other factors. For this reason, coatings of this type are satisfactory only when fluid concentration is low such as from intermittent spray or splash and when drainage will prevent accumulation.

In some cases, protective coatings are applied to parts at installation as well as at subsequent maintenance periods. The coatings may not be necessary for protecting the rubber, but may represent a general application, such as used in painting machine assemblies. Caution should be observed to avoid use of enamels or paints containing driers (oxidizers) or other chemicals which may be injurious to rubber. The use of common oil paints has occasionally caused serious trouble from accelerated oxidation effects. Under no condition should such coatings be expected to be impervious to extreme hazards. In those cases where thick and continuous films of foreign materials occur, it is advisable to consider the use of a more compatible body material in the part, or employ mechanical solutions such as shrouding, shielding, or remote installation.

As suggested, it is frequently necessary to protect metal components against corrosion effects if the metal in itself is susceptible. Commonly used protective coatings are available for this purpose. In general, these may be divided into two classes, nonmetallic and metallic.

[3] U. S. Patent 2,362,008.

The nonmetallics are commonly lacquers of the "spirits" type without "driers," thus avoiding an oxidizing effect on the rubber. For purposes of production facility, these are frequently a dual-purpose type which combine metal and rubber protective qualities.

Any of these types of coatings should be used with a degree of caution since it must be remembered that they are vulnerable to mechanical damage and must be maintained if conditions require, just as any metal paint necessitates touch-up or replacement. Unusual corrosion protective powers are too frequently assigned to this class of materials in spite of the fact that similar films used on all-metal parts have well-recognized limitations.

The semi-metallic and metallic corrosion resistors used on adhered rubber-metal parts are much the same as those common to the metal industries, except as to processing limits imposed by the chemical or temperature susceptibilities of the rubber compound, since the protective coating is almost always applied after the adhesion process.

Steel, brass, and other commercially platable metals may be coated with cadmium or zinc up to thicknesses of 0.0002 in. plus dichromate stabilizing treatment where desired. Heavier coatings may be used in special cases. Anodizing may be used for aluminum alloys. Parkerizing and similar treatments with applications of wax coatings or lacquers can sometimes be used, but these are not preferred since cost and process factors generally do not justify them.

The plating or chemical processes used to treat adhered goods are controlled in a special manner to avoid injury to the adhesion bond. It is advisable then if such treatment is required that this be done by or under the supervision of the rubber manufacturer.

ACKNOWLEDGMENT

Acknowledgment is due to the personnel of the development and product engineering departments of the Motor Products Division, United States Rubber Company, for the accumulation of test and manufacturing data and the many field observations upon which this paper is based. Credit is also due to Mr. G. Giusti of the process development department, Tire Division, United States Rubber Company, for his work on adhesion surface characteristics.

PSYCHOLOGICAL FACTORS IN THE DESIGN OF EQUIPMENT[1]

By MASON HAIRE

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THE pressure of wartime demands in recent years has forced research workers in many areas to a reconsideration of a group of problems which have been largely neglected—the problems centering around the design of equipment for human use. Many of the specific applicat ons of findings that arose in this line are useful only within the limitations of the military service and the exigencies of a wartime economy, but the same forces that compelled attention to this area in wartime exist today, and it is useful to examine the results of recent research to extract implications for current design problems.[2]

At first glance the research seems to be peculiar to the military establishment, but beneath the superficial aspect of the problems encountered are characteristics of all equipment that must, in the last analysis, be operated by human beings. The services had certain problems which tended to focus attention more sharply on the need for a consideration of engineering for human use, but the problems are not at all necessarily limited exclusively to the military situation. The military faced the task of using a wide variety of new and complex pieces of equipment where the importance of speed and accuracy of operation were at a premium. They had an unusually large and varied labor pool from which it was necessary to draw operators for this equipment and, further, it was extremely important to minimize the time required to train men for their combat tasks. Each of these demands represents a similar force in the industrial picture, and although its intensity is caricatured in the wartime setting, it has a counterpart in the industrial setting. The need for maximizing speed and accuracy is essentially the same whether the criterion is the defense of a formation of bombers or the achievement of efficient high production, and the limitations imposed by the equipment to be used on personnel selection and classification, or the problem of the cost of training men to use it are common to both situations.

The work that was done in the military service tended to fall into three classes. In the first place, there were problems of control. If an aircraft must be operated within certain tolerance limits it becomes important to determine what extent of movement and what resistance to movement is best designed to let the pilot produce this precision. In the second place there were many problems of display. When an instrument dial must be read with maximum speed and precision, how many divisions should be shown on the dial and in what form? These and a host of similar problems demanded precise experimental determination for final design plans. Finally, there were many problems of the absolute limitations which the characteristics of the human operator put on the equipment. These problems are well illustrated in such things as the maximum *g* loading for pilots and many similar areas of investigation. The specific answers obtained are of little value to industrial designers but the method of investigation offers considerable promise for improvement in modern equipment.

NEED TO CONSIDER THE OPERATOR

The typical procedure in the design of equipment has been to give some attention to the characteristics of the human operator, but, usually, it is only the most cursory sort of consideration, and in many cases the usefulness and efficiency of the equipment could be tremendously increased by advance investigatory research. During the war the Army Air Forces received a gun sight that was designed by a large industrial firm and mass-produced for use on a large group of our bombers. The operation of the sight required the simultaneous complex co-ordination of both hands, and the major part of the delicate job of pointing was delegated to the left hand, where it was performed with great difficulty by most gunners. The explanation for this quirk of design which was current and readily accepted by most of us who used the sight was that two of the three basic designers of the control system had happened to be left-handed. The explanation may well be apocryphal; certainly I have never seen any evidence to document it, but it is illustrative of a common phenomenon in design—the failure to take adequate account of the human abilities involved and to plan design to utilize them maximally. Another instance of the same thing is cited by McFarland. On one of the aircraft developed for wartime transport service and now used commercially, the cigarette lighter and the control to feather propellers are similar and placed side by side on the dashboard. Fortunately, one or two experiences with the wrong button led to a hasty correction of the situation. Once more, even casual attention to the human characteristics of an operator would have considerably improved the efficiency of design.

In many instances, however, the problem is not so simple. The corrective procedure is not to be found in armchair psychologizing about the nature of the operator, but rather the weight and value to be attached to the human factor must be given serious attention and is a matter for detailed research and planning. Throughout the war there was a program of research that was designed to discover and eliminate the mechanical sources of bullet dispersion in the air-borne .50-caliber machine gun. Presumably this was done on the theory that if you build a machine it should be made as precise as possible, and that a machine gun that is pointed at the same spot twice should hit the same spot both times. In the abstract this may be true, but in application the justification for

[1] One of a series of reviews of current economic literature affecting engineering prepared by members of the Department of Economics and Social Science, Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Opinions expressed are those of the reviewer.

[2] Typical of recent publications on this subject is: "Human Factors in Air Transport Design," by Ross A. McFarland, McGraw-Hill, 1946.

In addition to this, the *American Psychologist*, the professional journal of the American Psychological Association, devoted the bulk of its March, 1947, issue (vol. 2, No. 3) to three articles which illustrate specific directions of this problem:

"History of Psychological Studies of the Design and Operation of Equipment," by William E. Kappauf.

"Psychology at the Naval Research Laboratory," by Franklin V. Taylor.

"Psychological Research on Equipment Design in the AAF," by Paul M. Fitts.

extending this to a gun is based on the assumption that the gunner is going to point the gun correctly both times. If he points the gun incorrectly, increased precision in the gun will guarantee that he will never hit the target. Actually, hitting an enemy plane is a percentage problem, and the formula for the probability of a hit is one in which both the bias introduced by the operator and the dispersion of bullets around his center of impact are variables. Under certain conditions of accuracy in pointing the dispersion should be maximized rather than minimized, and an absolutely accurate gun can make the probability of a hit approach zero. In this instance only the precise experimental determination of the characteristics of the average gunner could supply the information necessary to guide a designer to maximum efficiency.

EXAMPLE OF THE GYRO HORIZON

The problem of an adequate psychological design for equipment has drastic implications for the expense of training operators to use it. In the past we have typically accepted a design that was mechanically sound and sometimes cursed the fact that it was so complex that it took long and expensive experience to produce a competent operator. We can look at the keyboard of the typewriter in our own office for a striking example of mechanical design that is inefficient in the extreme. In many cases a thorough analysis of the problem from the point of view of the human who must learn to use the equipment, with perhaps an experimental determination of crucial aspects, could greatly simplify the difficulty. Wartime research provides a striking example of this. In learning to fly, the novice usually has great difficulty in becoming accustomed to reading the indication of the conventional attitude indicator or gyro horizon. In many cases, if the student is in a cloud bank or the like and must depend entirely on his instruments for orientation, a momentary misinterpretation of the correction necessary is serious and extreme. As they are typically constructed an attitude indicator consists of a fixed profile of a miniature plane which rests on a horizontal bar running across the instrument If the plane dips to the right the horizontal bar ("artificial horizon") turns to the left, so that the right wing of the miniature plane is dipped below the horizon, and the pilot must press the stick to the left to correct the situation. However, two things happen in this instrument which provide a psychological barrier to ready interpretation of the signal. In the first place, the miniature plane is fixed while the horizon moves, whereas what the pilot feels is just the reverse. For him the plane moves while the horizon remains fixed, so that his first job is to reverse the reading, to interject an intellectual interpretation before his normal response. In the second place, moving the horizon has changed the *direction* of movement. When the pilot feels his own plane move to the right the artificial horizon moves to the left, and the necessary correction is to move his own plane to the left in order to move the horizon to the right. Once more, he needs a sort of intellectual "second-guess" before he can respond to the signal. Considerable research was done with a Link trainer equipped with such a conventional instrument in one case, and in another case with an identical instrument except that the direction of movement of the horizon was reversed so that its direction corresponded with what the pilot *felt*, even though objectively it was reversed. The results showed clearly that the subjects learned more quickly and with less error to correct for changes in the attitudes of their plane with the modified instrument. It seems probable that if the horizon were fixed and the miniature plane made to move the results would be even more striking. The design of the conventional instrument had left out of account the characteristics of the operator's response to it, and had consequently produced an indicator that is difficult and expensive to learn to operate. In this particular case the remedy is not easy to see, since so many thousands of pilots have learned to use the original type, but it seems clear that the original design would have been improved by experimental studies before its widespread adoption. There seems little doubt, also, that many of the problems of learning in industry, where it often takes considerable time to produce a competent operator, could be greatly simplified by application of the same techniques.

PSYCHOLOGICAL APPROACH TO PROBLEMS PROFITABLE

In general, the result of the research work that has been reported seems to be that psychological work on problems of design may, in many cases, be extremely profitable. This is especially true where there are such questions as: How much training will be needed to produce an operator for this machine and will redesign shorten the time? How should the equipment be built to get the precision of operation required? What limitations do human factors put on the final operation of this equipment? Is the current design utilizing human abilities maximally? Where such questions as these can profitably be asked—and in the case of most equipment designed for human use, it seems that they can—past experience indicates that considerable profit can be gained from psychological experimentation while the equipment is still at the design stage. The plan of procedure in these cases is essentially the same for a wide variety of problems. In the first place, the research worker must be thoroughly familiar with the conditions of use of the equipment, with all the demands that are put on the operator in the normal "field" situations in which it is apt to be used. On the basis of this familiarity he is able to break the task down into its components to find the psychological stumbling blocks that keep us from getting most efficient operation or from the readiest learning possible. The next step is likely to be a laboratory test of a variety of redesigned mock-ups, or a systematic determination of the interrelation of certain of the variables which have been discovered in the operation of the equipment. Finally, the laboratory product has to be taken back to the field for a validation of the experimental changes and an evaluation in the actual situation of the efficacy of the redesign. These steps in the process of engineering for human use seem to be universal in the successful modification of equipment, and, where it has been possible to employ them in the design of equipment before its widespread production and adoption, they seem to have made large returns in terms of efficiency and precision. There seems to be little doubt, also, that the tremendous strides made in this field by wartime research offer a valuable source of material for problems of industrial design.

ENGINEERING FOR HUMAN USE

In many ways, this work has overlooked the most important field of investigation in the area. Most of the research that has been done to date in adapting equipment to the peculiarities and limitations of the humans who will use it has been on more or less microscopic abilities and liabilities—the redesign of a control here and there to change the pressure required to operate it, or the modification of a signal light to insure attention in an emergency. All of the research reported in the publications mentioned covers this sort of material, and while the work has paid large dividends in these areas, it leaves an even larger and potentially more profitable field still untouched. We have so far concerned ourselves with comparatively small and relatively unimportant aspects of the people involved—the activities of muscle groups, the span of attention, and the like—and we have almost entirely neglected some of the much more important characteristics of the people involved—their drives and emotions, their interests, and their anxieties. If, instead

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OPPORTUNITY LIES *About* YOU

By EUGENE W. O'BRIEN

PRESIDENT OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

FROM almost every economic point of view the South has gone ahead faster than any other section of this country in the last 25 years. This can be illustrated by many case histories of how capital from within the South, as well as from without the South, of how native ability, as well as imported ability, have been added to natural resources of land, of climate, of fuel and power, to improve the economic condition of the South, and to attain a higher production level, per machine, per workman, per plant.

The South of which I speak includes the Southeast as well as the Southwest—not a colony, but a functional part of a great nation—individualistic perhaps in temperament, in history, in custom, and in the fortunate circumstances of having greater undeveloped industrial possibilities than any other section, but so tempered by Northern industry, by Northern banking, by Northern labor, and even to some extent by Northern politics, that this vaunted individualism has lost substance, if not voice.

SOUTH STRONG IN NATURAL RESOURCES

The South occupies one third of the land area, supports one third of the population, produces one third of the agricultural and nearly one half of the mineral products, but is credited with only one fifth of the value of manufactured products; this last figure despite great physical and human resources admirably adapted to a highly developed industry. Basic land wealth is great. In its hills are coal, iron, and limestone for steel; in its ground, over one half of the solid fuel of this country, and over two thirds of the liquid and gas fuel; in its rivers and lakes over one half of the water resources of the entire continent.

There are many reasons why the South has not in the past 100 years enjoyed its just share of manufacturing. Perhaps greatest is a mechanical invention, that of the cotton gin by Eli Whitney, which turned the attention of the South from industry to agriculture, for only the South could raise cotton; the whole world could process it.

As a result, while the South in 1810 manufactured 30 per cent of the total value of manufactured goods in this country, this dropped to 13 per cent at the time of the war between the states in 1860, despite the fact that nearly one half of the nation's wealth was in the South. It dropped to less than 7 per cent after the war, and climbed back to 13 per cent only in 1900. By 1923, the percentage had risen to 15 per cent, but by 1939, it had reached 21 per cent, the most spectacular growth in such a short period of time ever shown by any section. The percentage is even higher today.

INDUSTRY ON THE INCREASE

Between the last two complete censuses of manufactures, 1929–1939, the South gained 32 per cent in the installation of prime movers, the ability to make power, a basic factor in all industry, whereas the rest of the country lost 1 per cent because of the depression. In this same 10-year period, the South's use of purchased electricity increased 27 per cent against 14 per cent for the rest of the country; such power use rose from 22 per cent of the total to 25 per cent.

Address presented at the Keynote Luncheon at the Spring Meeting, Tulsa, Okla., March 2–5, 1947, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Most of this recorded gain started and took place in the period just before the war. While similar basic figures are not yet available, there are many dependable indications which point to striking wartime industrial gains. One is the electric-power-use figures mentioned, issued each month and each year by the Edison Electric Institute, which show that while we went from 22 per cent to 25 per cent of the total electric power used in this country between 1929 and 1939, between 1939 and 1943, we went from 25 per cent to 27 per cent, stepping ahead during the war at even higher rate.

There are also fairly accurate figures which show that over 60 per cent of the $3,500,000,000 dollars invested in new chemical plants since the war started were invested in the South—in plants which have more chance of reconversion to peacetime products here than elsewhere. Because of the general nature of our resources and of our processes, southern production, of such chemical-engineering plants in 1943 and 1944, was well over 30 per cent of the total of the nation, a much higher figure than we ever had before the war.

GROWTH IN INDUSTRIAL POPULATION

Perhaps the most stable and dependable basic wartime figures were those gathered by the Bureau of the Census to show civilian population growth in some 137 industrial districts in this country, employing well over 50 per cent of the nation's population. The findings were based on ration-book records which proved even more conclusive and complete than the house-to-house canvass figures of 1939—everyone wanted sugar and shoes. They eliminated the military but, as you know, the South had more than its share of that group during the war! These findings showed that: 9 of the first 10; 19 of the first 25; 29 of the first 50 of such industrial districts in percentage of manpower growth were in the South.

This industrial-population growth constitutes the greatest fundamental gain made by the South during the war, for the South has long needed skilled labor, technicians, engineers. The gain in trained men and industrial leadership has been definitely greater in the South than elsewhere and is filling one of the South's greatest needs.

As to what may happen in the future, we can only advance opinions; but there are numerous significant factors in favor of the South, most of them secondary to this proved gain of industrial skill and manpower.

The natural resources of the South, minerals, power, fuel, and the like, will command greater attention and respect now that the war is over, because of the general depletion of our national resources by the war.

Engineering and economics have also encouraged the current trend toward industrial decentralization. Fundamental is the fact that, with plants located in the Chicago, New York, San Francisco, Atlanta, and Dallas areas, a national manufacturer can reach over 90 per cent of all markets overnight by freight. Still undeveloped are the Atlanta and Dallas areas.

TYPES OF SOUTHERN INDUSTRIES

Most of our southern industries are of the so-called process type, manufacturing from natural resources the raw materials used by other industrial plants. The unit price and the unit profit of southern manufacture per pound, per ton, per yard, is

lower because we do not have fabricating industries, i.e., jewelry, fine goods, knickknacks, which build dollar volume. To correct this there is a positive movement to bring to the South a wider range of profit from the various steps which are interposed between resource product and consumer product Thus we have the cream of business profit still ahead of us, with no tariff barriers to hurdle within this country.

The South entered the last war with some 95 per cent of its industrial floor space occupied and was building rapidly for civilian production when the construction emphasis was shifted to war production. The rest of the country had less than 70 per cent of its industrial space occupied. Presumably more of the war building will be converted to peacetime use here in the South than elsewhere, and our construction will continue at a greater pace than elsewhere.

Two metals whose use increased tremendously during the war have particular southern significance, i.e., aluminum and magnesium.

Because of climatic conditions and terrain similar to that over which much of the fighting in the war had to be done, most of the military training during the war years was in the South. This gave to thousands of men a much better acquaintanceship with this area than they otherwise would have had. This should be an invaluable asset, for after we Yankees get over the first shock of hot weather, of grits, and of corn pone, we like the South and see its opporunities.

The war has largely wiped out the southern wage differential. The South no longer has "cheap labor"—thank God for that. This means the mechanization of many industries formerly served by hand labor, the introduction of more labor-saving and material-handling equipment. This means—more important than any other factor—the keeping at home of our great reserve of young natives.

THE PRIME IMPORTANCE OF THE ENGINEER

This war established the prime importance of the engineer, for it was an engineering conflict, but it also set up new responsibilities which he must meet. Proved so effective in raising production to unforeseen heights for war, he must in the postwar period develop means of using such production for peacetime purposes, toward the paying off of war debt, toward the raising of standards of living, and toward the betterment of mankind in general. He must broaden his vision, his experience, his service, by applying his talents and his imagination to greater, more humanistic fields.

Economic opportunities are great for the engineer, and they lie all about us in this great developing Southern industrial region. Professional opportunities are also great for the engineer, particularly for the junior and the student engineer, and they lie all about us, in the possibilities for joint and unified local activity and service, and in the advancement of the entire profession.

Engineering Research Laboratory Management

(*Continued from page 386*)

vice, storage facilities, library facilities, employees service, building rearrangements, etc. The centering of these services in a single group to which the technical personnel can go has been found to be essential.

Some of the experiments in an engineering research laboratory require the assignment of skilled experimental mechanics to help construct the equipment and, in certain instances, to help in running the experiments. For instance, when a large airplane is to be static-tested (see illustration at beginning of paper), it is necessary to have experimental mechanics make and modify the equipment as the tests progress. It has been found convenient to have a special group or groups of experimental mechanics who are especially skilled in experimental work, such as structures, mechanical and hydraulic, so they can be assigned to various research projects as required. In general, these mechanics are highly skilled manually, and the accumulation of years of experience of helping with tests of this nature makes them a valuable group for research operations. This type of personnel should not be confused with the research-technician type, since the latter has considerable technical training and only a moderate amount of manual skill, except in very special fields.

The preparation of the final reports for each research project is of course one of the most vital of the laboratory operations. The research engineer is basically responsible for the preparation of the report which is approved by the research supervisor, the research director, and others concerned. After approval, the report is distributed by the service organization to those who have been authorized to receive it. It should be remembered that the main tangible asset which the company receives from a research investigation is the final report. If the report had been available, either from the literature or from some other organization, it would not have been necessary to do the experimental work. The actual value of a report should not be underestimated, for on the average, the actual expenditure to obtain the report is nearly $3000 in certain organizations. The problem of putting the report into the hands of those who should have it and keeping it out of the hands of those who should not have it, is one of the important problems of research management.

In conclusion, it should be re-emphasized that engineering research management is not fundamentally different from other business management, but it should be recognized that it is a blend of many types of operations included in a small organization which must act with speed and accuracy.

Psychological Factors in the Design of Equipment

(*Continued from page 400*)

of paying attention only to relatively small problems like the design of controls, we shifted to macroscopic problems like plant layout, the organization of production lines, or the selection of proper units of work, it is possible that the size of the return would be proportional to the size of the problem attacked. Currently we expect a return in precision from using the right hand instead of the left. If our production design managed to maximize the egoistic satisfaction that comes from doing a complete job, our return might come in terms of an interest in the job itself, with all of its endless ramifications in terms of harmony and job satisfaction as well as production. If we can extend the principles of engineering for human use to the point where our units of work and the work situation itself are designed to provide satisfaction for the social and egoistic needs of the personality involved, we may be on the brink of tapping unknown resources, not only in efficient production, but in the whole area of the relation of the industrial worker to his job.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Biotechnology

TEACHING and research on the human problems of engineering have been inaugurated as fundamental activities in the Department of Engineering, University of California, Los Angeles, Calif., according to an article by Craig L. Taylor and L. M. K. Boelter, member A.S.M.E., of the university's department of engineering, appearing in *Science*, Feb. 28, 1947. This program, which represents an effort to develop a biotechnology as a basic discipline in engineering education, embraces those features of human physiology, psychology, and hygiene which are pertinent to engineering practice.

In many phases of engineering, essential design criteria are based upon human physiological characteristics. Ventilation is in part based on respiratory needs and, jointly with heating and air-conditioning, serves the needs of body-temperature regulation and thermal comfort. Illumination requirements depend fundamentally upon the properties of the visual sense. Indeed, all aspects of environmental control, including also noise abatement, reduction of bacterial, physical, and chemical contamination of the air, and functional aspects of industrial design, take their origin from human needs and tolerances.

The structure of the human body, both statically and dynamically, is often an important consideration in engineering design. Applied anthropometry finds important utilization in aircraft-cabin appointments, machine design, and comfort seating. Recent improvements in amputation prosthesis may be credited to the collaboration of engineer, physician, and limb fitter. Here, the engineer performs invaluable service through application of his knowledge of analytical mechanics and the strength of materials. Similar training and experience is useful in determining structural limitations in the human body relative to design of safety harness, such as is used by the steeplejack and by the military aircraft pilot. These problems point to the need for a systematic structural analysis of the human body, and it is but a short step to incorporate the study of anatomical materials, paralleling instruction in engineering materials.

The capacity, efficiency, and endurance of the human machine in physical labor is the concern of every engineer who assumes administrative duties, and doubly so for the production engineer. These factors underlie the principles of scientific management and time-and-motion analysis. When the additional stresses of environmental temperature, pressure, or anoxia accompany the work, physiological tolerance may be a critical concern. Hours of work, on-the-job feeding, and rest periods, are also phases of the physiology of work which form an important part of a comprehensive biotechnology.

To implement the need for better training of engineers to assume leadership in practical, on-the-job human relations, the standard phases of psychology, such as motivation, learning, social behavior, perception, and emotion, must be applied to such practical problems as industrial relations, job training, personnel management, and wage-and-hour policy.

The biotechnical program contributes also to prominent contemporary aim of the profession, namely, to broaden the base of engineering education to include humanistic-social studies. These studies aim at a better understanding of social, economic, and cultural values, and the development of moral and ethical concepts essential to public welfare.

While the physical sciences have traditionally formed the basis of engineering, and it is the common view (among most engineers themselves) that engineering deals solely with machines, processes, circuits, and structures, theorists agree that the functions of the engineer should be defined less in terms of conventional fields of application than in terms of the method he employs in solving the technological problems of society. It is therefore both logical and practical that a biotechnology should develop within the framework of engineering training and practice.

Basic in the program are two courses which cover the pertinent facts of human biology and the interaction of man with his environment. The first of these courses, the dynamics of human function and behavior, deals with the physical structure, thermodynamics, and machinery for the accomplishment of work of the body, and with practical psychology. The second, the influences of environment on man, treats of his interaction with atmospheric, thermal, bacterial, radiational, and chemical aspects of the environment, and also the socioeconomic setting. It may be noted that certain topics are predominantly physical and physiological, others psychological; but in so far as possible, an attempt will be made to avoid the common but regrettable separation of these aspects and to integrate them in the most rational manner possible.

The possible ramifications of the biotechnical element throughout engineering research and practice are almost infinite, but some of the engineering fields in which the basic human aspect is of significant importance in design and control are: Acoustics, aeronautics, architecture, food technology, illumination, industrial design, production and fabrication, industrial hygiene, personnel management, safety, sales, sanitation, and ventilation and air-conditioning.

These biotechnical elements will serve as the foundation for applications in other engineering courses. As examples, the effect of vibration on the human system will be incorporated into dynamics courses, skeletal kinematics and dynamics will underlie the study of certain nonmechanized operations, and the fields of acoustics and illumination will be placed upon psychological and physiological bases as well as the physical basis. Thus it will be sought to interweave the biotechnical material throughout the engineering curriculum.

Jet Propulsion

A DESCRIPTION of the research work now in progress in the field of jet propulsion was given by Comdr. J. J. Baranowski, U.S.N., at the meeting of Section M—Engineering, of the American Association for the Advancement of Science, held in Boston, Mass., Dec. 26–30, 1946.

The four major jet power plants discussed were the rocket, the turbojet, the ram jet, and the intermittent jet motors.

The production of thrust in any jet motor is accomplished through the increase in momentum of the working fluid as it passes through the device. It can be shown theoretically that this thrust varies directly with the square root of the absolute temperature in the combustion chamber and inversely as the square root of the molecular weight of the gases resulting from the combustion of the fuel. Basic research contributing to advancement in the field of jet propulsion is directed in large part toward increasing the temperature that can be tolerated in combustion chambers and turbines through the advancement of new high-temperature-resistant materials, and reducing the molecular weights of the products of combustion through the use of new fuels composed of elements of low molecular weights.

HIGH-TEMPERATURE ALLOYS

While research is directed toward the design of alloys which can be used at temperatures around 1800 F (see "High-Temperature Alloys," pages 37 and 38 in the January, 1947, issue of MECHANICAL ENGINEERING), another investigation in the program of research in heat-resistant materials is aimed at something to withstand temperatures as high as 5000 F. The intermetallic compounds which have high melting points and corrosion resistance at elevated temperatures appear to be one of the most fruitful sources of such materials at the present time. Specifically, the chromium borides are receiving a great deal of attention because of their high melting points and retention of hardness at extremely high temperatures. Preliminary investigations have shown that these borides cemented with nickel or cobalt also exhibit these properties to a marked degree. Equilibrium diagrams for the nickel-chromium-boron and cobalt-chromium-boron systems must be established in order to determine the solubility of the chromium borides in nickel and cobalt. From this information a first step can be made toward designing a suitable material for use at these extremely high temperatures.

Other metallurgical research investigations include welding techniques as applied to heat-resistant materials, a thorough study of corrosion phenomena at elevated temperatures, and statistical studies to correlate laboratory data with actual service or simulated service test.

Another approach toward increasing the performance of materials at high temperatures has taken the form of investigations of new cooling techniques. Partially successful attempts have been made to circulate coolants through channels in turbine blades. Another technique which shows promise is sweat cooling through the use of porous materials. Powder metallurgy involving fabrication under pressure followed by sintering shows promise of producing materials which lend themselves to use in sweat-cooling techniques.

COMBUSTION

Through a study of precombustion phenomena which includes the dynamics of mixing, turbulence, and heat transfer, and the chemical kinetics of the combustion process itself, it is hoped to improve the efficiency of utilization of the energy obtained from combustion of present fuels.

Coupled with these studies are many in the field of thermodynamics. The equilibria occurring during combustion must be established if an accurate calculation of flame temperature is to be made. This requires knowledge of the specific heats of the compounds involved, some of which are relatively new. In many cases accurate determination of this characteristic has not been made. Other physical properties such as vapor pressures over the temperature range occurring, transitions in physical state, heat of vaporization, melting, and sublimation points must be determined for the products of combustion of the new fuels. The pressure, volume, and temperature relationships, and the equations of state of the gases resulting from combustion must all be known if fuel performance is to be completely evaluated.

FUELS

Another large field of research in jet propulsion being examined intensively by many investigators is that of new fuels. It has been pointed out that the lower the molecular weights of the products of combustion the higher the resultant thrust. The need for such fuels has led the investigator to search for new compounds. Many of those showing promise were heretofore viewed as chemical oddities, but some are now becoming quite important as potential jet fuels.

The usefulness of these fuels to date has in most cases been very small. This has resulted in the broad current program to establish their characteristics, both chemical and thermodynamic. A good jet fuel must not only produce constituents of low molecular weight but must also be highly exothermic in its reaction with a suitable oxidant. This high heat of reaction is also tied up with the density of the fuel. The characteristic used to represent the thrust production quality of a fuel is called "specific impulse," and is defined as the pound-seconds of thrust produced per pound of fuel burned. It has the dimensions of seconds. Other characteristics of jet fuels must also be considered in choosing chemicals and these may have more bearing on the ultimate choice than "specific impulse." The availability of a fuel on a scale sufficient to support the use of a missile during wartime must be considered. It would be foolhardy to design a missile about a fuel which can be manufactured only in limited quantities. In almost all cases jet fuels by their very nature are dangerous to handle and to store. Toxicity must also be considered as a factor. In most cases these new fuels have been so little used that preparation on a laboratory scale has been their only source. Much work must be done before manufacture on a large scale is possible. This means the development of new processes, the erection and test of pilot plants, and final construction of large facilities before new fuels can contribute in a major way to advancements in jet propulsion.

Work is going forward on configurations of combustion chambers and nozzles, shapes of turbine blades and buckets, diffusers, flame holders, and other devices. A great deal of this work is empirical in nature due to the difficulty confronting the investigator in confirming theoretical considerations through observed data because of limitations placed on means of measuring the high temperatures involved. Complete temperature charts showing the temperature existing at many points in combustion chambers, nozzles, turbine blades, and exhaust flames are necessary and much work in instrumentation is being done to accomplish this end.

A special phase of research in jet propulsive devices which is of interest to the Navy is the possibility of substituting water for air as the working fluid in the jet motors. It might therefore be possible to develop new and possibly much more efficient water propulsive devices than the present propeller types. The intermittent jet could function with water entering through the valves, a water-reactant chemical could raise the pressure in the combustion chamber upon reacting with the incoming water, and a slug of water would then be ejected out the tail pipe at much increased velocity. In this manner the momentum of the water, the working fluid, would be increased, and thrust would be developed. Much work is being done in investigating all possibilities and the results show considerable promise.

Oxygen-Accelerated Combustion

TESTS being carried out by the Steel Company of Canada Ltd., Hamilton, Ont., using oxygen to accelerate combustion in open-hearth furnaces are described by E. T. W. Bailey, a combustion engineer of the company, in *The Engineering Journal* February, 1947.

The furnace used to conduct the oxygen tests has a nominal capacity of 175 net tons and taps around 180 tons. The inside dimensions are 43 ft 6 in. long and 15 ft 6 in. wide. The depth below the floor-plate level is 30 in. The area at floor-plate level is 534.74 sq ft. There are two checkers at each end, having a length of 23 ft × 11 ft 6 in. and a width of 16 ft 1 in. The mean depth of the checkers is 14 ft. The waste-heat boiler of horizontal fire-tube design has a nominal rating of 577 boiler hp. Both forced- and induced-draft fans are in use. The furnace is equipped with fuel-air-ratio controls for both oil and gas, automatic reversal control by temperature difference, constant oil-flow controller valve, and recording flowmeters for air, oil, and gas. In addition there is a modern furnace pressure control actuating louver dampers at the outlet of the induced draft fan.

The first important test was made on March 10, 1946. This test was to indicate what data should be collected and what instruments might be needed to furnish information for tabulation, so as to give an over-all picture from which the effects of the oxygen could be studied.

The test consisted of admitting an average flow of 587 cfm of oxygen 3 in. above the stream of fuel oil entering the furnace. A 1-in. pipe was used to conduct both the oil and the oxygen into the furnace. A total of 122,134 cu ft of oxygen was consumed over a period of 3 hr and 27 min. The furnace was reversed on a time basis, and the oxygen valves were manually operated so that flow was practically constant. This precaution was used in order to ease the problem of controlling pressures at the source of supply.

Observation of the flame showed an intense white streak where the steam-oil mixture raced outward from the burner pipe, parallel to the oxygen stream. This "silver streak" seemed to preignite the oil, so that a brightness was developed in the flame almost as soon as the oil emerged from the burner pipe. No prolonged black core existed in the flame, as is common during the regular scrap-melting operation. The flame was intense yet short and did not extend beyond the middle door.

The roof remained relatively cool. The melting effect on scrap was interesting. The heavy crop ends soon began to flow and lighter scrap seemed to settle much sooner than usual, and in some respects resembled a brush pile being burned in the woods. There was general agreement that the speed of melting was materially increased.

Even with the use of oxygen, the amount of extra fuel that can be economically burned by a furnace is not the maximum fuel it can burn. Increases in fuel input from 35 to 62 per cent above normal were tried, and it appears the optimum amount will settle out at around 40 per cent.

A second major test was made on June 9, 1946, in which a burner was used which had been adapted for combination burning of gas and oil. The oxygen was admitted into the regular gas passage and formed an annular ring around the oil-burner pipe. It was considered this would facilitate in a physical way the uniform and speedy mixture of oxygen and oil. It is interesting to note that while a pressure of 63 psi existed in the oxygen line, 75 ft from the burner, a pressure of —34.5 in. water column existed in the annular space through which the oxygen was passing. This type of burner was selected because of its advantage for dual service, as well as to suit the probable delivery conditions of large volumes of oxygen at an estimated pressure of 5 psi.

The second test was highly satisfactory. It was noted that the heats melted hard. This unforeseen condition delayed the final tapping time until adjustments could be made. It was also evident that no standard for judging the improved performance was at hand. The scrap was charged much faster, while records did not show exactly similar heats. Estimates of time required without oxygen, given by first helpers, melters, and supervisors, varied considerably.

It was therefore decided to run a blank heat and let the operators do all they could to make a heat in as short a time as possible.

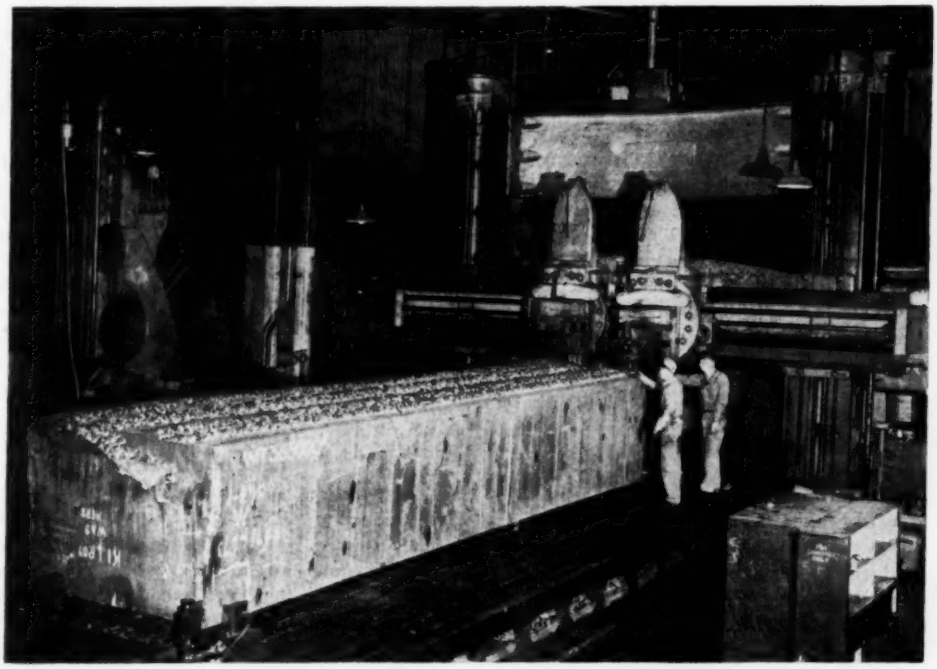


FIG. 1 A SIDE MEMBER OF THE UNIVERSITY OF ROCHESTER AND U. S. NAVY CYCLOTRON MAGNET IS SHOWN GOING THROUGH ONE OF THE NATION'S LARGEST PLANERS AT HOMESTEAD WORKS, CARNEGIE-ILLINOIS STEEL CORPORATION (The weight of this piece, as shown painted on its side, is 365,000 lb. After finishing operations it was bolted in place above the pole pieces of the magnet, which, over-all, will weigh about 1100 tons, as compared with the 15-ton magnet of the University's present 7,000,000-volt atom smasher. The new cyclotron when completed in the next two years will be used for basic research in nuclear physics at the high energy level rather than for industrial applications of atomic energy.)

The results of tests 3 and 4 using oxygen and the blank heat (4-A) are indicated in Table 1.

TABLE 1

Item	Test No. 3	Test No. 4	Test No. 4-A
Total metallic charge, tons	396430	415165	399470
Hot metal, per cent	41.9	43.5	41.6
Charging time, hr-min	2–45	2–22	3–55
Time to addition of hot metal, hr-min	3–18	3–09	5–20
Melt time, hr-min	6–50	5–50	7–50
Total time of heat, hr-min	8–10	9–05	11–10
Tons produced	179.10	188.95	174.95
Yield, per cent	90.5	91.0	87.6
Charge to tap, tons per hr	21.9	20.72	15.67
Btu per ton, thousands	2939	3486	4346
Fuel as U. S. gal oil per net ton	19.49	23.11	28.8
Fuel as Imp. gal oil per net ton	16.23	19.25	24.0
Fuel rate as oil—U. S. gal per hr	500	610	496
Slag, actual FeO, per cent	9.8	6.0	11.5
Oxygen, rate of flow	700	800	None
Oxygen used, cu ft	155700	165500	None
Oxygen used per net ton, cu ft	873	877	None

The average of tests 3 and 4 compared with test 4-A indicates: Reduction in time, 24 per cent; increase in tons per hr charge to tap, 36 per cent; and reduction in fuel, 35 per cent. (This is probably higher than can be expected, as fuel was used generously in order to beat the time set by the "oxygen" heats. Other tests indicate a possible saving of around 17 per cent.) The yield on all tests has been consistently high.

Recent spot tests indicate that on some furnaces the increase in output will exceed 40 per cent. An accurate figure cannot of course be obtained until a given furnace has been operated through a campaign, using oxygen during the melting period of every heat. The life of the furnace under the new conditions is another question mark. Given proper supervision, and assuming a reduction in the extent of the drop in refractory temperatures between heats and during charging, there should be an increase in total time between rebuilds. The consumption of brick per ton of steel should be reduced.

While the use of oxygen appears to shorten the scrap-melting time by at least $2\frac{1}{2}$ hr, it is probable that the bubbling of oxygen into the bath of molten metal will also substantially lessen the time required for refining.

If 98 per cent oxygen can be produced in large volumes for around 25 cents per thousand cubic feet, its arrival as a cheap plentiful gas heralds great industrial changes. In a steel plant it can be used to increase materially the capacity of any gas producer or heating furnace. Existing boilers may be forced to produce unheard-of amounts of steam, while blast-furnace gas may become a rich fuel. In the chemical industry, the output of sulphuric acid could be increased fivefold, even with existing equipment.

A German method of making 98 per cent pure oxygen inexpensively for commercial uses is described in two Department of Commerce reports (PB-368 and PB-44664). An abstract of these reports appears on pages 318 and 319 of MECHANICAL ENGINEERING, April, 1947.

Electronic Micrometer

AN electronic micrometer developed by the National Bureau of Standards utilizes the principle that radio-frequency energy radiated from a coil is at zero at the surface of a perfectly conducting shield adjacent to that coil. This phenomenon occurs because eddy currents are set up in the shield by the field of the radiating coil, and these eddy currents set up an opposing magnetic field at the surface of the shield. The opposing field exactly cancels the incident field at the surface of the metal plate. Theoretically, a pickup coil of zero thickness applied at the surface of the shield would receive no energy. It is, however, impossible to design a coil of zero thickness. Therefore compensation for the necessary thickness of the coil has been included in the design.

FIG. 2 MEASURING THICKNESS OF A PAINT SPOT WITH THE NEW ELECTRONIC MICROMETER

When the pickup coil is moved away from the shield, in the direction of the radiating coil, it picks up a certain amount of energy because the radiated field becomes stronger while the field set up by the currents of the shield becomes weaker due to the change in distance. This condition becomes more marked as the distance between the pickup coil and the shield increases. This is true whether the distance between the pickup coil and the radiating coil decreases or remains unchanged.

Because the metal background is not a perfect conductor and because the coil has measurable thickness, a minimum reading is obtained when the pickup coil is in contact with the metal background. This condition is corrected by the addition of a third coil which permits a zero reading to be obtained.

The radiating coil is fed a high-frequency current. When the micrometer is held at some distance from any metallic object, the field from the radiating coil induces voltage in the secondary (or pickup) coil, and this induced voltage is measured either on an oscilloscope or by an alternating-current meter. The linear indication of the change in distance between the micrometer and the metal background is indicated on the meter or oscilloscope.

With modifications, this principle can be employed in a micrometer, a phonograph pickup, a microphone, a thermometer, or a tachometer. In its use as a micrometer, the coil assembly is mounted on a movable shaft in such manner that it can be caused to approach or recede from a metallic plate. The material to be measured is placed between the pickup coil and the metallic plate and is pressed lightly between them. When the material is removed, the amount of current generated in the pickup coil is an indication of the thickness of the material which occupied the space. The meter indicating the output of the coil is calibrated, not in current or voltage, but in thousandths of an inch in order to give a direct measure of distance or thickness. The micrometer is about $\frac{1}{2}$ in. in diameter $\times \frac{1}{4}$ in. in length and is able to measure distances from zero to 0.02 in. Readings to 0.0001 in. are easily obtained.

Capacitance micrometers, with which measurement is made of the thickness of a nonconducting film separating the micrometer from a conductive background, are well known. It is impossible, however, to use micrometers of this type where the conductive background is either inaccessible or cannot be

accurately defined. Similarly, inaccuracies are likely to be introduced because of changes in the dielectric constant of the insulating film covering the metallic backing.

Testing Prosthetic Devices

A NEW testing machine has been developed at Northwestern University that will make an artificial leg "walk" at the rate of 3,000,000 steps in ten days—the equivalent of three years of normal wear.

The machine, called a fatigue tester, will permit faster testing and development of improved artificial limbs for this country's 20,000 veterans and 65,000 war workers who have had amputations.

A 300-lb load, one and a half times that of the average man, is shifted continually from heel to toe of the foot of the artificial leg at a rate of four complete cycles per second—which means that the leg actually is "running" as fast as the swiftest athlete. Thus the amount of punishment it would take over a period of years is concentrated into a few days or weeks.

In one test the durability of artificial leg fittings used at U. S. Army amputation centers was demonstrated when a leg with the fittings completed 7,190,000 steps, or three weeks of continuous high-speed walking, without failing. This was equivalent to seven years of normal wear, which is computed to be one million steps per year.

Knee and ankle mechanisms of light metal alloys may be the parts most susceptible to wear, as evidenced by tests of another model in which the plastic shank remained intact after 4,800,000 steps, but the metal knee cracked after 600,000 steps and metal bearings in the ankle after 410,000 steps. An experimental plastic limb now under test has undergone 5,300,000 steps without failure.

Electrical wire strain gages that translate pressure into measurable electric current are attached to various parts of the limb to record the exact pressure and tension in each part. Although the over-all load is 200 to 300 lb, some parts of the knee and ankle mechanisms are so small that pressure concentrated on them is sometimes as high as 9500 psi. The load on other parts, tests showed, is as low as 4 psi. A major problem is to design the limbs so that pressure is more equalized.

Preliminary tests indicate that a combination of riveting and bonding (plastic cementing) is the strongest means of connecting joints and that new plastic parts show promise of great strength. No plastic part of any limb has failed yet in the fatigue-testing machine.

In addition to testing, the Northwestern research group is studying all literature and patents on artificial limbs as far back as 1863. Their findings, which will include reports on legs, hands, hooks, and harnesses, and other suspension devices, will be presented in the spring to the National Research Council's Committee on Artificial Limbs.

High-Temperature Concrete

A CONCRETE which, it is claimed, can withstand temperatures as high as 3000 F has been developed by The Babcock & Wilcox Company. Known as "Kaocast," the product is being released after a long period of successful service trials under severe conditions. The new material fills a need for a refractory castable in the construction of industrial furnaces operating at temperatures ranging from the top limit of standard refractory castables up to as high as 3000 F.

It is reported that both in service trials and in laboratory tests, the material has shown excellent stability and resistance to spalling under repeated heating and cooling cycles. Other properties which give this concrete its durability include its exceedingly small volume change on initial firing, and its lack of shrinkage or expansion under continuous use at high temperatures.

Because it can be either poured into place like ordinary concrete used in construction work, or used as a ramming mixture, this material will effect considerable savings in furnace construction. This is particularly true of furnaces requiring extensive use of special shapes which were formerly made of kiln-fired materials or of refractory plastics. It can be used either for the quick fabrication of these special shapes, or to form part or all of the furnace lining.

Other applications where it will cut down construction time and reduce furnace maintenance include its use as a covering for studs in water-cooled furnace walls and in forming high-temperature baffles. Its ability to resist spalling also makes it suitable for use on furnace car tops, which are subjected to repeated heating and cooling cycles. Because its volume change is negligible under high temperatures, it is ideal for deep patching of spalled or eroded brickwork.

The material is supplied in dry form, ready mixed, and requires only the addition of water to make it ready for use.

Castings Inspection

INSPECTION and layout of castings by a three-dimensional method of projecting accurate layout drawings upon rough castings has been developed by General Electric engineers at the Pittsfield Works and has seen several years of successful application to thousands of intricate ferrous and nonferrous castings.

Originally designed to inspect and lay out parts for subsequent machining, this method has also been used for a rapid inspection of finished parts. Projection may also be employed during an actual machining process, whether the part to be machined is stationary or revolving. The equipment assures layout within fifteen thousandths of an inch.

The apparatus consists of a layout image projector containing a photographic glass slide of the finished casting layout. The

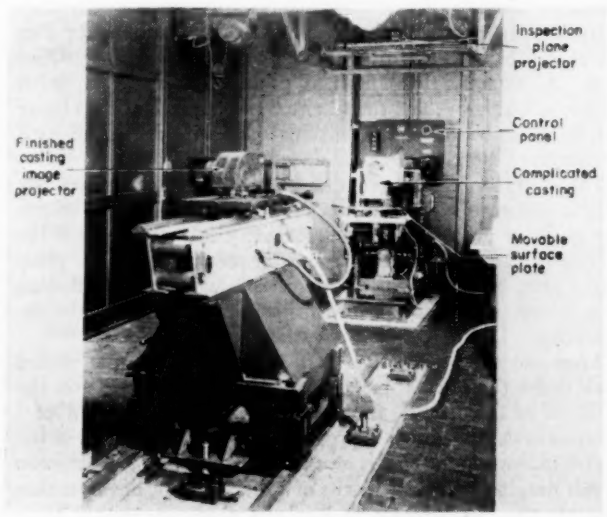


FIG. 3 THREE-DIMENSIONAL METHOD OF INSPECTING CASTINGS
(Installation shows projector, light wand, adjustable surface plate, and control panel.)

layout is projected by a lens directly upon the surface of the casting. To establish the plane of true projection and correct dimensions, a second projector—the inspection plane projector or light wand—over the inspection position is used. The light wand emits a sheet of light which falls vertically upon the casting.

Both projectors operate in unison through a self-synchronous system. Thus the light wand always designates the proper plane for the main projector's image as well as its correct focus and size.

The inspection pedestal assists in positioning the rough casting by means of an electric drive. An adjustable surface plate allows for the final location of the casting coincidental to the sheet of light from the inspection plane projector. Automatically, the finished layout will be projected properly on the rough casting.

When machining a piece which revolves and is symmetrical about the axis of rotation, the finished outline may be projected to serve as a template.

This template-projection system may be used in fabricating duplicate metal parts for tanks, boilers, and other burned-out and welded pieces. Variations of this system can be used for laying out intricate pieces, locating parts to be welded, shearing, and general layout operations.

Microhardness Tester

THE hardness of microscopic grains within a piece of steel can now be measured by a new microhardness tester designed at the Research Laboratory of United States Steel Corporation of Delaware. The new tester can gage the hardness of a single steel grain at as many as three points within the breadth of a human hair.

Like the Brinell, Rockwell, Vickers, and other traditional hardness testers, but on a much finer scale, the new device operates by indenting the polished surface of a steel sample. Its diamond-point penetrator under a load of a very few grams leaves a square mark which can rarely be seen by the naked eye. The diagonals of this tiny square indentation are measured in microns, or thousandths of a millimeter, and this reading is related to the load placed on the penetrator so that hardness may be computed.

Preparation of the sample of steel whose hardness is to be measured consists of grinding and finishing the sample with polishing paper, care being exercised so the grinding effect does not extend below the surface. Then it is polished on wet lead laps. Alternately the sample is polished to a mirror finish with a soft abrasive and then lightly etched with acid to bring out the grain boundaries. This dual process is continued until no disturbed metal is observed under the microscope.

The operator of the microhardness tester then places the sample under the microscope on a movable bed plate and selects the grain or area to be tested. When this is determined the sample is transferred to the penetrator mechanism. The penetrator arm, balanced with its adjustable weight suspended on knife-edges, slowly bears down its weight to make the indentation.

After the indentation has been made the sample is moved back under the microscope and examined. Depending on the hardness of the sample, indentations may range upward of 2 microns in depth, which is proportional to the diagonal of the square indentation. This is measured in microns. (One micron equals roughly forty millionths of an inch.) The device makes possible the measurement of hardness gradients within areas too small to permit satisfactory exploration with any of the usual hardness testers.

The tester consists of the indenter with a square-base, 136-deg diamond pyramid penetrator, the mechanical stage for holding the specimen, a microscope capable of magnifying the test field 500 to 1500×, and a control box.

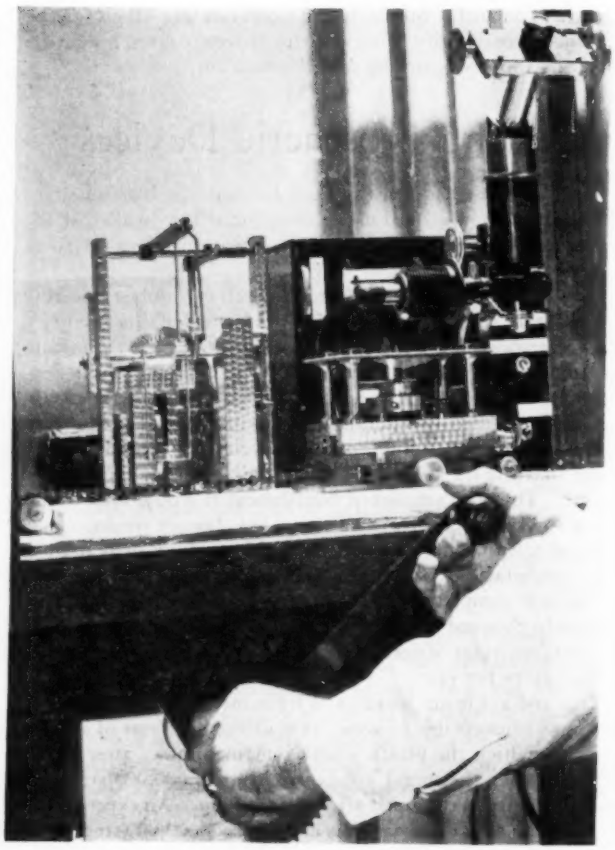


FIG. 4 MICROHARDNESS TESTER

[Tester consists of a penetrating unit (*left*) and mechanical stage (*right*).]

Underground Gasification

A GAS which could be used in manufacturing synthetic liquid fuels has been produced successfully by setting fire to one section of an underground coal mine, according to a recent Bureau of Mines announcement. The experiment is being conducted by the Bureau and the Alabama Power Company at the Gorgas Mine near Jasper, Ala. It is reported, however, that difficulty has been encountered in maintaining combustion.

Long interested in the practical possibilities of producing gas by burning unmined coal, Bureau officials stated that underground gasification may permit the use of impure coal and seams too thin to mine. It would also result in a more complete recovery. Today, coal mines leave an average of 35 to 50 per cent of coal in the ground.

Potential uses for the gas are many. It not only offers a new source of raw material for the manufacture of synthetic liquid fuels, including gasoline and lubricating oil, but a heating gas for burning under boilers in industrial plants. The gas may also prove a possible substitute for water power. In dry areas throughout the Rocky Mountain region and the west, electric power might be produced by using the gas in gas turbines.

Experimental work in underground gasification commenced in January, 1947, at the Alabama Power Company's Gorgas Mine.

The company was interested in the practical application of piping gas from a burning coal seam directly to the boilers of a near-by plant for use in place of coal to produce electricity.

Isolating a coal bed from an active part of the mine, two horizontal entries 6 ft in width were dug into a $2^1/_2$-ft coal seam and connected by a crosscut. Concrete pipings were installed at both ends of the two entries of the U-shaped structure. Several holes were core-drilled from the surface into the coal seam to take gas samples and temperature readings. To start the combustion process, incendiary bombs were dropped down several of these holes. Using a compressor, air was blown into one entry as gas emerged from the other. Air may be coursed through the tunnel from either direction.

Steady combustion was maintained and most mechanical difficulties were eliminated during the first 16 days of the experiment. However, the resistance resulting from roof falls and other undetermined causes prevented an air flow sufficient to obtain the desired temperature in the burning coal and the quality sought in the gas. Therefore a limited amount of oxygen was introduced to enrich the air, indicating the possibility of the continuous production of synthesis gas.

After the supply of oxygen was exhausted, an air blast was coursed through the tunnel which resulted in a steady improvement in operating conditions and gas quality. A relatively high-grade synthesis gas also was produced by alternately blowing air and steam into the burning mine. This method is similar to an underground gasification system employed in Russia which also utilizes alternate periods of air blasting and steaming.

Roof falls which occurred are believed to be as anticipated, according to Bureau officials. However, to study what has actually taken place in the earth during the experiment, strata overlying the burned area will be removed by bulldozers and shovels for analysis. The burned area will be steamed for several days and then flooded with water before extracting the stratified rock above the coal.

Considerable time was spent in making adjustments to equipment and apparatus in the first few weeks of the experiment. Further extensive research is required to determine definitely the technical and economic practicability of producing and using gas from a burning coal mine.

Materials Handling

A THREE-STEP plan for plant management to apply to its particular materials-handling operations as a means of reducing production costs, is offered by The Yale and Towne Manufacturing Company, Philadelphia, Pa., and has been worked out in conjunction with Dr. V. S. Karabasz, associate professor, industrial management, Wharton School, University of Pennsylvania.

First: Set Up the Staff. Management's first move in applying the plan should be to appoint a staff—a staff instructed to scrutinize handling operations and costs with the same care and zeal that has led to such remarkable development of the processing techniques used throughout American industry.

In most cases, the accounting department will be of little help—because cost-accounting systems generally do not set out separately the costs incurred in lifting, moving, and setting down again.

Sometimes the staff is best built from engineering personnel, sometimes from treasury, sometimes from production, and sometimes from the outside (specialists engaged for the job or new men taken into the organization for the purpose). But however the problem is approached, it is imperative to select men who are assiduous in detail, enthusiastic about the opportunity, imaginative, and buttressed by authority.

Second: Get the Data. Next, the staff should set about reducing to paper actual observed information and data. Here, organization of effort is most important.

One of the most useful means of spotting wasteful practices in materials handling is to select a sample incoming unit of some material or part or component or subassembly, one which is as representative of the over-all operation as possible, and record its progress through its entire history in the plant.

In the case of a valve manufacturer, it might be 1000 lb of body castings received from foundry, and followed through every handling and movement and pause, through more than a dozen machining and assembly and testing operations, right up to and into the final carton shipped to the dealer. It might be a piece of paper, which according to one recent study, was found to travel $2^1/_2$ miles in an office only 35 ft square, most of it waste movement.

After the material-unit to be studied has been selected, a form with certain essential headings should be prepared. The form should include columns headed: (1) Description of operation or activity; (2) classification of operations, such as handling, moving, inspecting, weighing, and packaging operations, temporary storages, and permanent storages; (3) manpower; (4) distance; (5) time; (6) equipment; (7) load capacity; (8) load characteristics; (9) number of units; and (10) weight. Every single action involving movement or positioning of the sample load should be listed.

It is also wise to make a floor plan of the plant, chart the path followed by the sample material unit, and file this diagram with the tabular information.

The plan should be to scale; and symbols should be used to indicate ramps, doorways, elevators, bridges, outdoor movements, and each of the types of operations listed in (2). Such diagrams disclose desirable relocations of processing tools, storage zones, and receiving points, and suggest such worthwhile measures as the widening of aisles and the reduction of grades.

The Yale and Towne Manufacturing Company has developed and printed special forms, layout paper, and instruction material for the easy assembling and filing of data along these lines. Copies are offered to industry as a contribution toward industrial cost cutting by reducing handling costs.

As an example, consider the case of a lot of 600 forgings which were received from a supplier by truck and were processed into the universal-shaft-forks of a piece of portable machinery manufactured for use in the textile industry.

The forgings were rehandled to such an extent that, actually, 12,600 units were manipulated, not just 600; 81,900 lb were rustled, not the mere 3900 lb which represented the shipping weight; 5 different types of materials-handling equipment were used; the total distance moved was 3015 ft; more than an hour and a half of time was taken up in transportation; 22 men were involved; and 3 handlings, 18 moves, and 8 temporary pauses were involved. The change of level was involved at 3 points, not to mention the many lifts involved in stacking at storage and picking-up-and-putting-down at every processing station.

This is the basic data collected and recorded for file. The prudent extent of collection of such data will be indicated by the case. It may be wise to study 5 or 10 typical components, to make a separate study of office supplies, to trace subassemblies and finished products from the last assembly to the carriers which take them from the scene, or to analyze movements between plant buildings.

Third: Summarize and Interpret. After the actual handling-histories are assembled, proper summarizations and interpreta-

tion can yield over-all views which are almost invariably startling.

One worth-while procedure is to study one, or a few, representative parts which go to make up the finished product and to multiply the totals for the representative part by the number of parts which make up the product.

Thus one can get indications of the total tonnage and the total number of items handled in the production of one lot of finished products.

Generalization of the collected data to encompass all the plant operations may also be performed on a per-day or per-week basis—multiplying the totals for the representative part by the number of similar lots handled in the time unit chosen.

For instance, if a manufacturer of textile machinery were producing 40 machines per day, each with 900 parts of which the universal-shaft-fork was considered representative, the summarizer could calculate daily parts production as 36,000 or consider this volume equivalent to 60 lots like the sample lot of 600 forgings. He could estimate the number of parts handled per day as 756,000 (12,600 × 60) and the tonnage handled per day as 5,000,000 lb or 2500 tons (81,900 × 60). He could figure on 34 miles of inside-the-plant hauling per day (3015 ft × 60) and 1260 separate handlings and movings of part lots (18 + 3 × 60).

To these totals should be added smaller totals summarized from studies of the handling of the finished products after assembly, and from consideration of the various materials which end up as crates or packages—all of course on a day basis.

Such detailed statistics will suggest means of eliminating useless rehandlings, needless lifts and travels, plant layout improvements, and that percentage of handling which is being done by old-fashioned and inefficient manual methods.

The matter of new equipment (trucks, cranes, hoists, and conveyers), the matter of loading methods (skids, pallets, skid bins), the matter of plant layout (aisles, elevators, docks, floor surfaces), and the matter of cost accountancy to segregate materials handling from processing charges—all resolve themselves logically and completely if surveys such as here described have been made.

Home Heat Pump

THE reversed refrigeration cycle can now be applied to keep homes either warm or cool, according to an article in the anuary, 1947, issue of *Science Illustrated*.

In the system described, water circulates through a closed pipe circuit in a 200-ft bore. Heat stored in the earth comes into contact with the cold pipe and is absorbed by the water. Pumped up the pipe, the water carries the heat to a water radiator, where it makes contact again with a colder fluid, the refrigerant used in the system.

Still seeking the cooler region, the heat is absorbed by the refrigerant gas, and moves with it to a compressor, where the gas pressure is increased. As in all such compressors, the temperature also rises. Leaving the compressor at a higher temperature, the heat moves to the air radiator over which cool air flows. Again seeking the cooler area, it moves into the air stream on its return path to the room, and warms the room. For cooling in summer, the cycle is reversed.

Operation of the system is entirely automatic and there is no combustion—thus no soot, ashes, smoke, or dust. The system described consumed 8070 kwhr in heating a 30 × 23.6-ft house and 13.6 × 20-ft garage from Nov. 27, 1944, to June 11, 1946. Degree-days totaled 4833.

Another system popular on the West Coast extracts the heat from the air.

Cutting Fluids

SOME observations on the cooling properties of water-mixed cutting fluids as indicated by quenching tests were reported by W. H. Oldacre, member A.S.M.E., president and general manager, and H. A. Erickson, junior A.S.M.E., mechanical engineer, D. A. Stuart Oil Company, Ltd., Chicago, Ill., at a Metal Cutting—Production Engineering technical session held during the 1946 Annual Meeting of The American Society of Mechanical Engineers.

It has been observed frequently that at temperatures above the boiling point of water, emulsions, soap solutions, and other similar water mixtures do not compare with pure water and salt solutions in quenching speed, and it is common practice to use a soluble oil emulsion as a quench to develop a dark oxidized surface or Barff finish where any appreciable hardening of the steel parts would be objectionable.

The poor quenching rates of emulsions and soap solutions have been pointed out, and it is indicated that contamination of aqueous quenching liquids with soap or other organic materials should be avoided.

A 10 per cent emulsion of oil in water gives a rate of 0.11 as compared with a rate of 0.48 for oil, using 1.0 for water as a basis.

To relate these and like observations to specific cutting fluids, four easily available straight carbon steels were selected to conduct the investigation. Two-inch lengths from one-inch-diameter hot-rolled basic open-hearth rounds were prepared and pack normalized in cast-iron chips to prevent surface decarburization. Table 1 gives the approximate analysis of the test pieces and the Rockwell hardness in the normalized condition.

TABLE 1

SAE No.	C	Mn	P	S	Rockwell No.
1020	0.18	0.33	0.025	0.030	59B
1035	0.38	0.76	0.020	0.038	90B
1045	0.43	0.80	0.031	0.041	93B
1095	0.91	0.42	0.029	0.036	27C

NOTE: Above steels are basic open-hearth carbon steels—hot-rolled bars.

The test specimens were heated in a controlled electric furnace to the desired temperatures and quenched individually in an agitated bath. The bath, held at a constant temperature, contained 1½ gal of fluid. Seven commercial emulsifiable oils were tested together with a standard quenching oil and distilled water. Table 2 gives the results of a laboratory analysis of the "soluble oils." The quenching oil had a Saybolt Universal viscosity of 100 at 100 F and was of the "compounded" type.

TABLE 2

Sample	Volatile	Saponifiable	Unsaponifiable	Water	Soap
A	4	0	83	3	10
B	2	6	84	2	6
C	2	5	82	4	7
D	2	6	80	4	8
E	1	5	82	2	10
F	4	0	63	3	30
G	5	25	46	4	20

Fig. 5 shows the hardness obtained when steels were quenched from 1600 F in water, soluble oil A (1-15 mixture in water), and the quenching oil. Similar tests were run using

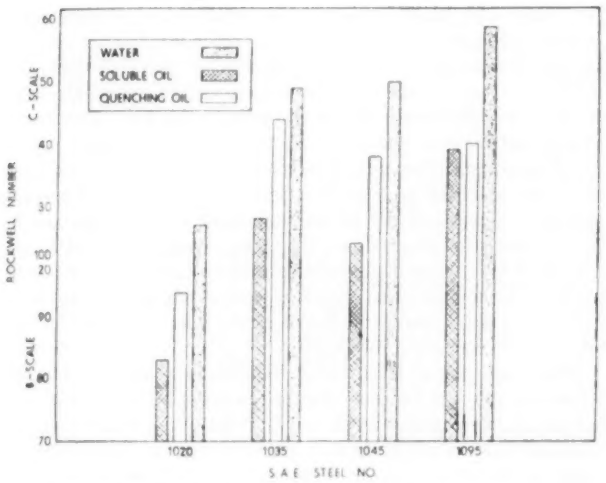


FIG. 5 HARDNESS RESULTS OBTAINED WHEN STEELS WERE QUENCHED FROM 1600 F IN WATER-SOLUBLE OIL A (1-15 MIXTURE IN WATER), AND QUENCHING OIL

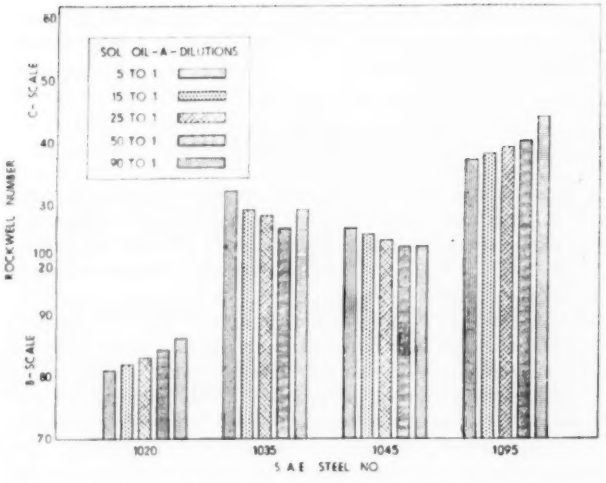


FIG. 7 EFFECTS OF VARYING DILUTIONS OF SOLUBLE OIL A

mean recommended temperatures for the specific steel, and results differed but little from those shown.

Fig. 6 compares the results of tests with five competitive emulsifiable products. The results for each grade of steel show little variation.

The effects of varying dilutions of soluble oil A are illustrated in Fig. 7. Surprisingly, the difference between a concentration of 20 per cent of oil and another of only 1 per cent resulted in a maximum difference in hardness of only 5 to 6 points Rockwell.

Fig. 8 depicts the results from the use of three widely different types of emulsifiable cutting oil when mixed as recommended by the manufacturer. Here again the difference is less than might be expected.

It is pointed out that these findings lead to the logical assumption that the functioning of cutting emulsions must be explained on some basis other than that of cooling efficiency in the tool-point area.

Past observations indicate that the temperature at the point of contact of tool and work metal is in the neighborhood of 1100 F. Regardless of theory of chip formation, this area is inaccessible to any but a small volume of fluid, so that cooling must be by conduction through adjacent metal rather than by direct contact.

The effect of the amount of heated metal involved cannot be neglected, and in quenching there is little doubt that cooling is better when the mass is less. In the case of metal cutting, however, heat is constantly generated and therefore probably the mass is less important.

Wartime developments and the experience of recent years with thread grinders and other high-speed grinding machines have emphasized the need for a better understanding of the relationship of the cutting fluid to the temperature of the work metal in the cutting zone.

In a field where for many years the cooling function had been considered predominant, it was found necessary to turn to oil when speeds and rate of metal removal were increased. The use of oils similar in many respects to those used in metal-cutting operations results in greatly increased wheel life, better work finish, and the virtual elimination of heat cracking and checking. That such improvement is because of better temperature regulation is not too easily proved, but is even more difficult to deny.

A limited investigation does not justify any final conclusions, but it is hoped that further attention may be drawn to this

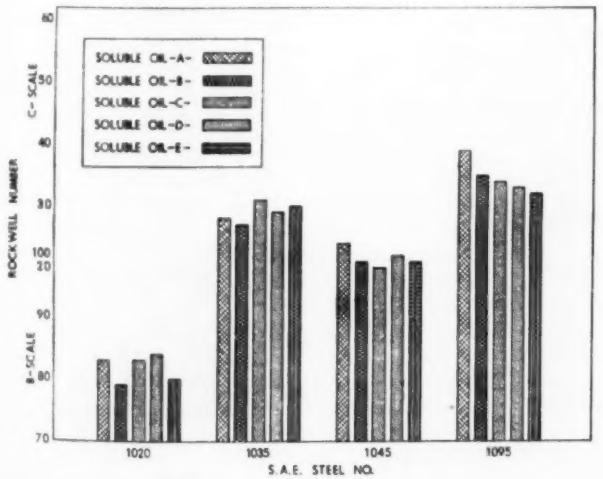


FIG. 6 RESULTS OF TESTS WITH FIVE COMPETITIVE EMULSIFIABLE PRODUCTS

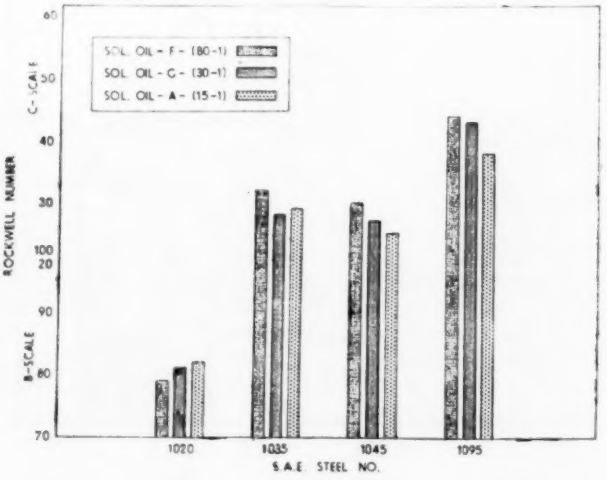


FIG. 8 RESULTS FROM USE OF THREE TYPES OF EMULSIFIABLE CUTTING OIL WHEN MIXED AS RECOMMENDED BY THE MANUFACTURER

complicated matter of cutting-fluid behavior and in any case that references to "coolant" will be modified by a more careful consideration of the subject.

Coin Changer

AN electrically operated coin changer, attached to any vending machine, that dispenses the product and returns correct change to the customer is described in *Product Engineering*, March, 1947. Figs. 9 and 10 illustrate the changer diagrammatically.

If the machine is empty a switch turns off the coin viewing light and the coin is returned through the slug chute. Should a run of large coins exhaust the change column, a light warns the customer to "Deposit no nickels." "Jackpotting" or continuous cycling as might be caused by a jammed coin is prevented by a relay connected to the coin actuating lever. The changer consists of a mounting plate upon which are mounted three coin chutes B_1, B_2, B_3; a change dispenser D; solenoids S_1 to S_6; relays R_1 to R_4; coin switches C_1 to C_5; coin receptacle E, slug rejector F, and coin viewing receptacle G, where the inserted coin is visible as proof of genuineness. The coin changer is a product of the Bell Aircraft Corporation, Burlington, Vt.

The cycle for a 10-cent coin is as follows: Coin receptacle E guides coin into slug-rejector F. Here the coin is subjected to a series of tests by means of magnets, wires, and unbalanced arms. If defective, the coin is returned to the customer. If acceptable it falls into coin chute B_2. Here it strikes actuating arm W of coin switch C_2, closing contacts and energizing relay R_1. This relay causes the vending machine to dispense the product, energizes coin-sight release solenoid S_1 that releases the coin deposited in viewing receptacle by previous cycle and holds the 10-cent coin from passing into this receptacle until the cycle is completed. Relay R_2 further causes the 5-cent coin rejector solenoid S_5 and S_4 to be de-energized, so that arms O and P move into the slug rejector to close off the coin path while the machine is in cycle. Relay R_2 energizes solenoid S_2 causing a 5-cent coin to be rejected from change dispenser D. The 10-cent coin passes down the chute where it is held by the coin stop V. When the vending-machine cycle is completed, solenoid S_1 de-energizes, allowing coin sight door L to close. The door carries coin stop V out of the way, so that the coin falls into the viewing receptacle.

When only seven 5-cent coins remain in change column N, actuating arm LL of low change switch C_4 moves into coin column N, closing the circuit in C_4. Solenoid S_4 is de-energized, releasing arm P, which moves into the path of 10- and 25-cent coins in the slug rejector, thus deflecting these coins to the customer. This also lights the low-change warning light mounted in the vending-machine cabinet. When supply of change is too high, actuating arm R depresses switch C_5. Solenoid S_6 then pulls arm Q from within coin chute B_1, thus allowing nickels to pass directly into the coin box. When the supply of merchandise has become exhausted, the empty switch opens, causing coin viewing light to go off, and de-energizes all relays and solenoids. Arms O and T move into the path of 5-, 10- and 25-cent coins, deflecting them through the slug rejector for return to the customer. This same action occurs in the event of a power failure. To prevent a jammed coin from holding coin switch closed and initiating continuous cycling, a coin

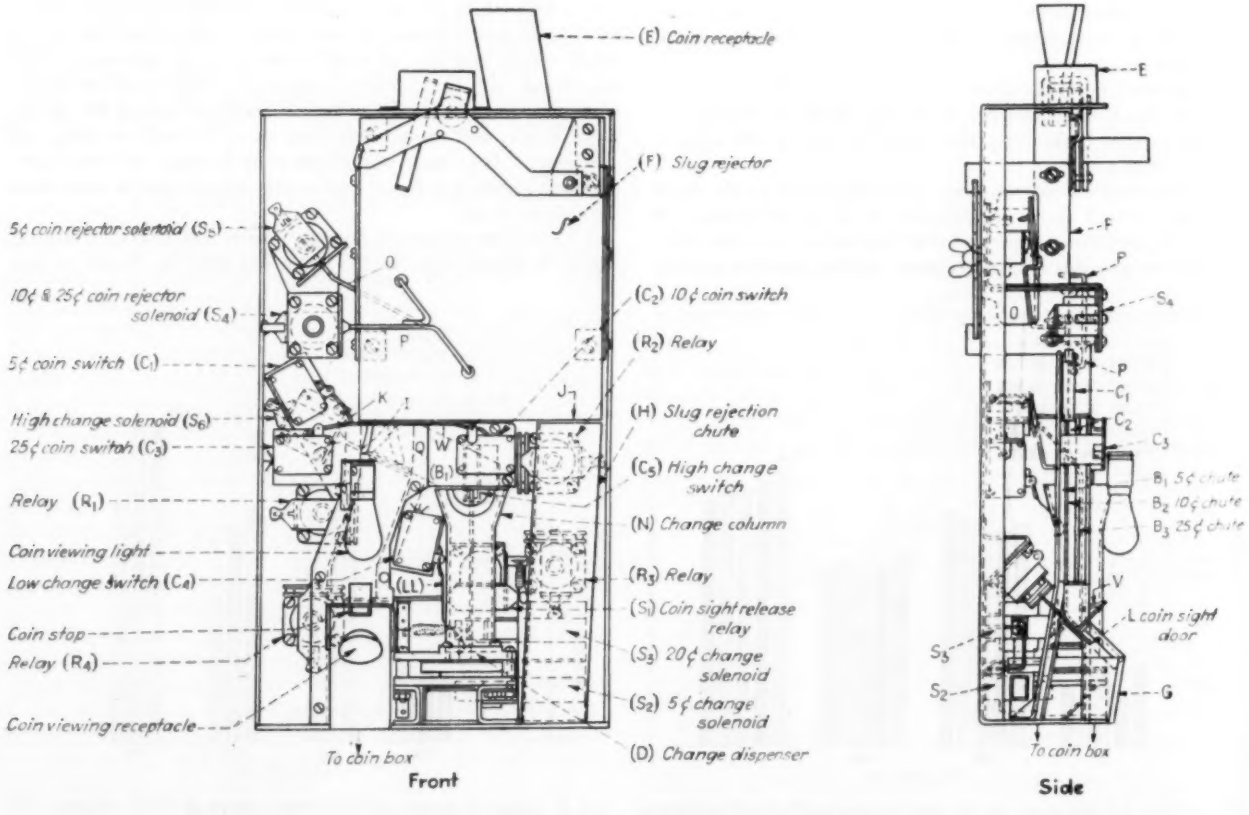


FIG. 9 DIAGRAMMATIC SKETCH OF COIN CHANGER

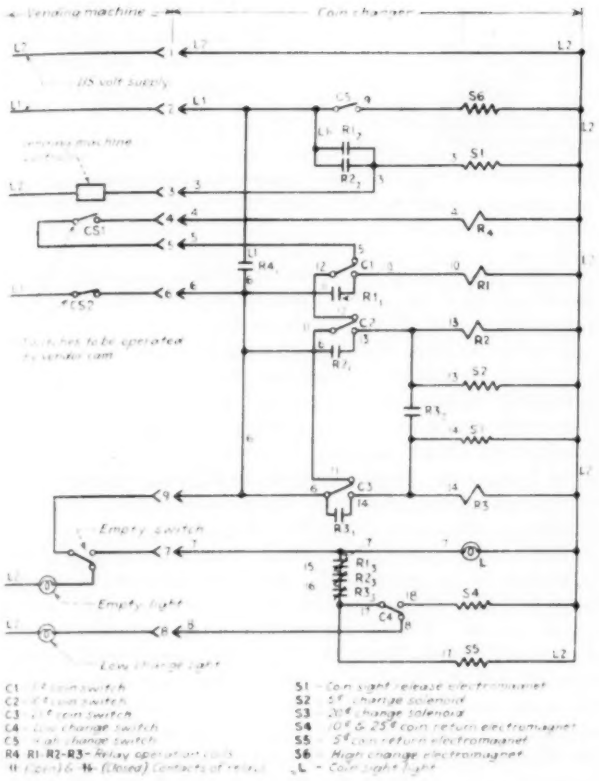


FIG. 10 ELECTRIC CIRCUIT OF COIN CHANGER

contacting the actuating arm of the coin switch closes CS_2. This causes the vending-machine motor to start. The motor, through a cam, closes CS_1 and opens CS_2. If coin passes freely by the switch after having made contact, the actuating arm returns to normal. R_4 completes the circuit to the vending machine and energizes the coin changer. A jammed coin holds the actuating arm in a depressed position thus preventing R_4 from becoming energized and starting dispensing cycle.

Fluid Dynamics Courses

A NEW and unique program of courses to be given jointly by the Graduate Division of the College of Engineering of New York University and by the Graduate School of Stevens Institute of Technology, which will combine instruction in the field of aerodynamics, hydrodynamics, and applied mechanics and which will make use of the experience, special teaching, and experimental facilities of the two colleges, was announced recently by the officials of the two graduate schools. The course will be known as "fluid dynamics of aircraft, ships, and related bodies" and will lead to a master's degree.

The one-year, full-time course will open in September, 1947, and enrollment will be limited to fifteen students. Choice of candidates for the course will be made by the two colleges on the basis of careful judgment of individual records.

The course will allow a student to emphasize either hydrodynamics or aerodynamics in his study but will cover a wide range of instruction in the two fields which will include mathematics, fluid mechanics, aerodynamics, hydrodynamics, and dynamics of free bodies.

Wind tunnels at New York University's Daniel Guggenheim School of Aeronautics will offer the students laboratory experience in aerodynamics. The college has two wind tunnels, one 4 × 4 ft in size, and the other 7 × 10 ft and capable of wind speeds from 5 to 120 mph.

In the hydrodynamics field the Stevens Institute Towing Tank facilities will be used. Stevens has three towing tanks in which model hulls are tested. One is 95 ft long and equipped with a wave-generating machine, a second 75 ft square is used for steering and turning tests, and a third 313 ft long and 12 ft wide is used primarily for seaplane model tests.

Electronic Digital Computers

THE National Bureau of Standards has been commissioned by the Bureau of Census and the Office of Naval Research to construct two high-speed electronic digital computing machines which, it is reported, may revolutionize the methods of classification and compilation of data and of numerical computation.

The computers are to be of the automatically sequenced digital type. Automatic sequencing reduces the intervention of a human operator to a minimum while electronic rather than electromechanical or relay-type components assures speeds measured in millionths of a second for the arithmetic operations of addition, subtraction, multiplication, and division.

The machines will be capable of handling huge compilation problems and of solving the most complicated differential equations in engineering and physics. They will perform, upon instruction, predetermined sequences of calculations running into the hundreds of operations without the intervention of human operators. The result will be the solution of problems in days that would take years if attempted by present standard machines.

Authorities in the field of applied mathematics say that wind-tunnel and model-ship-basin testing will be aided by machine computation. At the present time it is only theoretically possible to predict all of the changes involved when an aircraft is in flight, for example. Practically, mathematical solutions to these problems are impossible because it would take years to solve the equations involved by present methods. Answers are now found by laborious tests in wind tunnels and ship basins, observing the action of one part of a craft when certain forces are applied at another part. With the new high-speed electronic machines much of this information will be available in a matter of minutes from the computer, in printed form if desired.

The machines under construction are to have built-in "intelligence" capable of distinguishing between orders and data presented in coded form. Design specifications call for internal memories in which 5000 or more 10 or 12-digit numbers and orders combined can be stored. The machines will be able to transfer numbers and orders between their internal organs and memories within a few millionths of a second. Numbers and orders will be taken automatically from a continuous storage medium in the form of a film or tape, and the machines will know when to depend on their internal memories and when to obtain information from this external tape. At predetermined steps in computation, the computers will be able to choose and execute alternative orders upon the basis of the result of the preceding steps. They will know when computations have been completed to a preassigned accuracy and will either print the results at that time or store them on an external tape for printing later.

At the present time, a typical census problem, involving the multiplication of 100,000 pairs of 5-digit numbers followed by summing the products, takes approximately 12 working days

exclusive of card handling and data punching. The electronic digital machine for the Census Bureau will handle the same sequence in 10 minutes at the most. A problem of great importance to the Navy is the determination of vibration characteristics of ship machinery and aircraft. One such problem, arising in the flutter analysis of aircraft wings, now takes about 5000 machine-hours by the most efficient method available. With the projected Navy computer, it is said that the problem will be solved in a few hours.

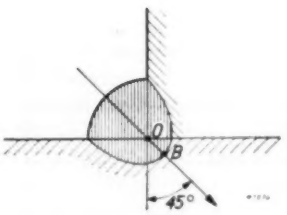


FIG. 12 THE STRENGTH OF THE WELD IS LARGELY DETERMINED BY THE ROOT PENETRATION, WHICH IS DEFINED AS THE DISTANCE OB

(The root penetration is considered a positive in the direction of the arrow. A negative root penetration means that a channel remains open in the corner under the head.)

Contact Arc Welding

RECENTLY a new method of welding was described in the December, 1946, issue of MECHANICAL ENGINEERING, pages 1077 and 1078, called "contact arc welding," in which the electrodes can be kept resting on the workpiece from beginning to end, while the coating of the electrode is in continuous electrical contact with the workpiece. This new method was the outcome of an investigation carried out with the object of making touch-welding easier and of more universal application.

Another article in *Philips Technical Review*, October, 1946, entitled "Penetration and Welding Speed in Contact Arc Welding," by P. C. van der Willigen, discusses advantages, both in welding technique and economy, which are obtained with the new type of electrodes.

Besides the electrode type contact 15, two other types were developed: contact 18 and contact 20. They were developed from the ordinary electrodes Ph. 55, 48, and 50, respectively, which differ mainly in the composition of the coating.

Thus contact 15 and Ph. 55 have in common the high impact value and the insensibility to sulphur in the material to be welded. Contact arc welding can be carried out with contact 15 in all positions except the vertical, where the free arc must be used.

Contact 18 was specially developed from Ph. 48 for vertical down contact arc-welding. This electrode can also be used quite well in other positions. It gives unusually good results in underwater welding, touch welding and self-starting being particularly valuable because under water the welder can see very little while actually welding, owing to the water around the arc becoming turbid.

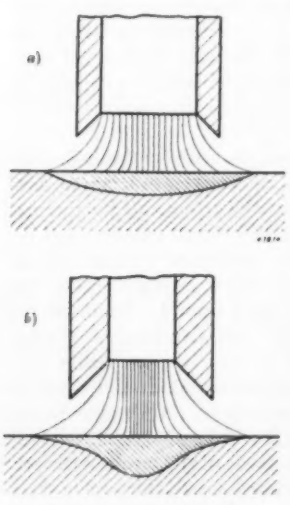


FIG. 11 SHAPE OF THE PENETRATION (*a*) IN THE CASE OF AN ORDINARY ELECTRODE, AND (*b*) IN THAT OF A CONTACT ELECTRODE

Contact 20 was developed exclusively for down-hand contact arc-welding. It has an exceptionally high speed since it was developed from the already fast type Ph. 50.

Particular attention is directed toward the shape of the penetration, the part of the workpiece that is fused during welding. When a bead is welded on a flat plate the penetration resembles a segment of a circle, as shown diagrammatically in Fig. 11 (*a*) for an ordinary coated electrode.

In the first test with the heavy contact electrodes it was found that the shape of the penetration differed considerably from the normal, the penetration being deeper in the middle and shallower at the sides, Fig. 11 (*b*). This different shape of the penetration is characteristic of all contact electrodes.

The peculiar form of the penetration with contact electrodes is in many cases of great importance because the deep penetration in the middle makes it possible with V-welds (and with fillet welds made in the flat position) to apply a first layer directly with a heavy contact electrode, say, with a core diameter of 5 or 6 mm. It is unnecessary to deposit a first layer with an electrode of small diameter. This results in fewer layers and a saving of time, as well as other advantages.

With a certain diameter of contact 15 the arc voltage is closely dependent on the current used; with high current the arc voltage is highest. The penetration is also found to depend directly on the current. When a fillet weld is made in the flat position with two strips of 12 mm thickness successively with different currents, and the depth of the root penetration is measured on the cross sections, the result shown graphically in Fig. 13 is obtained. A similar graph could also be drawn for V-welds and the relation between the current and the root penetration would be found to be qualitatively the same. Therefore, when making an open V-weld with backing strip and using contact 15 (6 mm diameter), a high current must be used for the first layer in order to secure sufficient penetration to the bottom of the weld.

Because of the slight penetration at the sides, even when the heaviest contact electrodes and the highest currents are used, no trouble is experienced from undercut, that is, burning away of the original material at the edge of the bead. During the investigation it was found that the heat efficiency of the contact electrodes—the ratio of heat expended in the fusing of the metal to the total amount of heat supplied—is higher. This is because the deep cup envelopes a larger part of the arc than the ordinary electrodes used with the free arc. The heat in the arc is thus used to greater advantage and the radiation of the arc into space is diminished. As a result of these two facts, the welding speed (the amount of metal deposited per second) is considerably higher with contact electrodes.

Averages of a large number of tests showed, for example, that contact 15 is about 50 per cent faster than Ph. 55. The diameters of the two types are particularly suitable for comparison because they contain equal amounts of iron and slag-forming substances and because the maximum current in both cases is 375 amp.

In addition to the greater speed of contact 15 as compared with an ordinary coated electrode of the same weight, there is also the possibility of using a heavier contact 15 in many cases

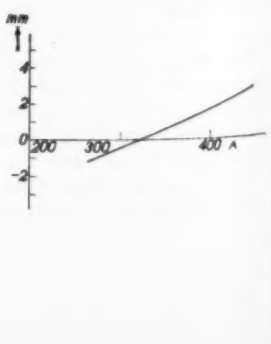


FIG. 13 THE RELATION BETWEEN THE ROOT PENETRATION AND THE CURRENT USED WITH CONTACT 15

where a lighter type of an ordinary coated electrode would be required. This also results in greater welding speed, since with a heavier electrode more iron is deposited per second. In such cases this gain in speed must be added to the 50 per cent.

With the lighter electrodes, in many cases, the highest permissible current is determined by the fact that when using up the last piece of the electrode the top becomes red-hot and this is apt to cause the rod to bend. Since the cores of contact electrodes are much smaller than those of corresponding ordinary electrodes it might be expected that the highest permissible current for contact electrodes would be much lower, but actually the difference is not great. The coating of the contact electrodes is heavy and conductive and it dissipates the heat much better than the coating of the ordinary electrodes, thus compensating for a large part the effect of the smaller thickness of the core wire of the contact electrodes. With ordinary electrodes it is of only secondary importance whether or not the coating makes good contact with the holder. In the case of contact electrodes it is of great importance that the coating make good contact with the holder, because the upper end of the core wire would become red-hot much sooner than in the case of an ordinary electrode. The heads of the contact electrode holders are made of copper and are constructed in such a way as to have a reasonably high heat capacity and conductivity.

Rocket Tests

A REPORT by Lieut-Col. Harvey Rivkins on the U. S. Army Ordnance Department's German V-2 rocket firings at White Sands, New Mexico, appears in the March-April, 1947, issue of *Army Ordnance*.

The summary of the rocket program, which started on April 16, 1946, reveals that the Army Ordnance Department now has the "know-how" for firing the German V-2. The percentage of failures, roughly about 35 per cent, as compared with the German 5 per cent during the war, has enabled ordnancemen to correct the deficiencies, getting at the same time a shade better results than were obtained by our Axis foe.

In addition, a height of 114 miles, never attained before in this country, has been reached. Prior to the rocket shoots, using a balloon as a vehicle, scientists were able to send aloft instruments to a height of about 20 miles to secure upper-air data.

The Ordnance Department experimented with rockets reconstructed from about 200 carloads of parts shipped to the White Sands Proving Ground from Germany where they were gathered by ordnance technical intelligence teams.

Of the 17 rockets fired in 1946, one was tested statically, and 10 roared into the sky perfectly, being completely successful in flight. Four showed failure of the control mechanisms during flight, and the fuel supply was cut off from a control station on the ground by radio so that the missiles were sent crashing harmlessly into the desert.

One propulsion unit exploded. Another rocket, starting a freakish flight, tilted 15 deg on take-off, stabilized itself and then, continuing its normal course, reached an altitude mark of 93 miles. When the fuel was consumed and the rocket completed its trajectory, it streaked to earth 131 miles away from the launching site.

The first rocket firing was from a crude concrete static test stand. The rocket was tied down, the fuel ignited, and a roaring flame shot out of the base like a comet's tail onto the sands 100 ft away until the fuel was consumed. From this "zero" altitude in the static test, to a high of 200,640 yd or 114 miles into the ionosphere, was the feat accomplished in a little more than 6 months. Greater accomplishments are expected during 1947.

Ordnance has gained knowledge from each firing. In the field of ballistics, the Ballistic Research Laboratory, Aberdeen Proving Ground, Md., obtained valuable data by tracking every missile with radar, telescopes, phototheodolites, and Doppler radio. Knapp Bowen cameras are also used to photograph the trajectory for the first few seconds after launching.

From these calculations, complete records have been assembled on the position, aspect, and velocity of the rocket throughout its flight. These data are of utmost importance to the designers of guided missiles. In addition, they form the basis for factual evaluation concerning behavior of component parts, physics of the upper atmosphere, and military countermeasures.

The General Electric Company which is assisting Ordnance, has utilized recording devices on each missile to measure component performance, turbine speeds, combustion-chamber pressures, burning of fuels, rocket skin temperature, structure vibration, and fuel-tank pressure.

Other vital data obtained thus far concern: Cosmic-ray count, ionosphere experiments, effects of cosmic radiation, solar spectroscopy, temperatures and pressures at high altitudes, and photography of the earth. The latter was accomplished by Johns Hopkins cameras from an altitude of 65 miles. The resulting photographs showed the curvature of the earth and 40,000 sq miles.

Although recovery difficulties have limited the success of some of the rocket firings, more important data on cosmic rays, solar spectroscopy, and pressure and temperature have been obtained than by all other means during the ten years prior to 1946. With improved recovery techniques, it is expected that revelations of even greater scientific importance can be expected during 1947.

On the other hand, radar equipment superior to that now in use to detect and track the supersonic missiles will be required for adequate countermeasures against supersonic rockets.

Distribution

IN an address which he delivered March 11, 1947, at the National Market Conference, Chicago, Ill., Fenton B. Turck, member A.S.M.E., president, Turck, Hill and Company, Inc., New York, N. Y., emphasized that business management can dissipate the impact of a buyers' strike by increasing distribution productivity. The result of increased productivity would be a 22 per cent reduction in average consumer prices. This achievement is possible through the practical application of improved methods and not the use of theoretical cuts in wages, profits, and merchandising discounts.

This is possible by the use of a new yardstick for distribution. This yardstick is productivity per man-hour. Man-hours is an old, well tried, and standard measurement of production, but in distribution man-hours has not been utilized as a means of measuring productivity.

Industrial economy is divided into two halves: Production and distribution. For further progress, the power of the distribution must be increased until distribution power reaches the same high level as the present power of production.

Production power is measured in terms of productivity per man-hour. The same standard can be applied to distribution.

In 1939 there were slightly more than 10,000,000 men engaged in the various functions of distribution. Separating them into categories, the 1940 census states that approximately 7,000,000 men were engaged in the retail trade and 1,700,000 men in the wholesale trade, both figures including sales and clerical help;

800,000 in rail and ship transportation; 500,000 in trucking; 33,000 in warehousing; 20,000 in credit bureaus and collection agencies; 18,000 in advertising; and several thousand more in miscellaneous services. In these various functions of distribution, this labor force of 10,000,000 produced services worth $44,239,000,000. Based on each man working 40 hours per week and 50 weeks per year, the distribution productivity of each man-hour was $2.17. It therefore took 46 man-hours to produce $100 worth of services.

On the production side, during 1939, a production labor force of only 8,850,000 men, working 40 hours a week but only 45 weeks a year, manufactured $56,843,000,000 worth of products. In factories, therefore, the productivity per man-hour was $3.57 and it took only 29 hours to reach the $100-figure.

These figures show that a man engaged in distribution is only two thirds as productive as a man engaged in straight production.

Practical industrial-engineering surveys and methods can successfully guide management in the task of increasing distribution productivity.

The following general approaches will be found useful in almost every case:

1 Physical handling: There should be simplification and wider use of materials-handling equipment. Such simplification depends on the adoption of procedures widely demonstrated in the physical handling processes of production. They apply to operations, modernization and expansion, and include time and motion studies, product-flow surveys, product-handling facilities, plant and store layouts, structural redesign, more efficient clerical methods for handling orders, and the institution of many other effective and available techniques.

2 Unessential distribution functions: Unnecessary clerical work, duplicate and uneconomic functions of distribution, and overlapping promotion expense by the producer as well as the wholesaler and retailer should be investigated and possibly eliminated.

3 Knowledge and control of distribution functions and costs: Market surveys, sales analyses and research; studies of customer relations and requirements in product design; full analyses of sales territories for increased usage and new business; cost accounting, budgeting, and control of individual functions or services in distribution for basic pricing policies and consumer price reduction; evaluation of productivity of a sales organization; methods to stabilize both seasonal and cyclical demand for specified products; and the recording of field data for information and control purposes are some of the proved procedures that can increase productivity in distribution.

A number of progressive companies, both large and small, have notably increased productivity per man-hour in certain functions of their distribution systems. The methods of application may vary, although each has been proved through years of use. The principles employed for these increases in distribution productivity are fundamental, however, and adaptable to many different companies in various industries.

Up to the present, the man-hour has been a yardstick applied to only the production half of industrial economy. It is now proposed that it be applied to the distribution half as well.

The number of man-hours required for each separate function of distribution can be calculated with ease. The formula is simple arithmetic: The amount of goods handled divided by the number of man-hours utilized directly and indirectly in performing the function. For example, if five men in a warehouse handle $500,000 worth of gross business per year—assuming a 40-hour week and 50 weeks of work—it takes one man-hour to warehouse $50 worth of product. If a retail store employing the owner and one clerk, sells $50,000 worth of goods per year, the man-hour handle amounts to $12.50. In such simple illustrations the man-hour clearly appears as a completely workable common denominator of distribution productivity. Broken down—function by function, department by department—the man-hour can become a proved engineering basis of measurement for all functions of distribution, just as it is now for all functions of production.

Distribution power will increase as distribution productivity increases. Distribution productivity will increase as the man-hour is accepted as its standard and engineering techniques are employed to make each man-hour more productive. And in the background is production power, almost limitless if it can be absorbed without interruption by that increased distribution power made possible through more effective use of our 20,000,000,000 annual distribution man-hours. High production and effective distribution are the creative ingredients of a rising standard of living. If they can be combined successfully the last thirty years of achievement are only a foundation for the achievements of the future.

Diamond-Die Drilling

A NEW electrical method for drilling small diamond dies, used in drawing and shaping extremely hard and fine wire, has been developed at the National Bureau of Standards, eliminating almost 100 man-hours from older processes. This discovery, it is reported, has completely revolutionized the fine-wire diamond-die industry, introducing it into the United States for the first time in history.

A diamond die consists of five surface areas: The primary cone, the secondary cone, the reduction cone, the bearing, and the exit cone.

The new process replaces the older mechanical die cutting with high-voltage drilling followed by electrolytic drilling.

The primary cone is drilled by means of high-voltage sparks formed at the point of a needle electrode in contact with the face of diamond. These sparks release the energy stored in a condenser which has been charged to a high voltage by a transformer. The condenser is charged through a "quenched" gap consisting of a number of very small gaps in series.

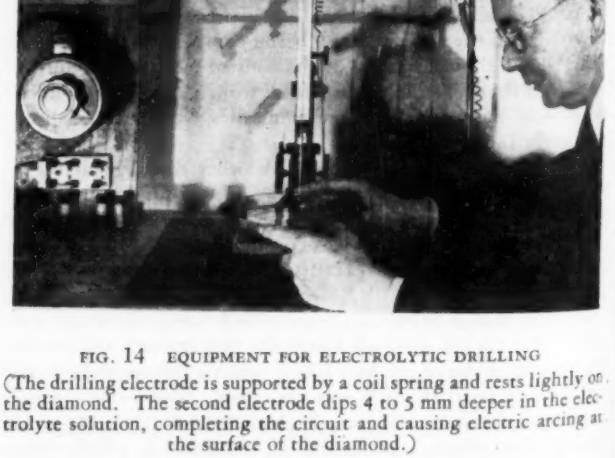


FIG. 14 EQUIPMENT FOR ELECTROLYTIC DRILLING

(The drilling electrode is supported by a coil spring and rests lightly on the diamond. The second electrode dips 4 to 5 mm deeper in the electrolyte solution, completing the circuit and causing electric arcing at the surface of the diamond.)

When rising voltage is applied to the circuit, sparking occurs first at the quenched gap. This is followed, as the voltage is increased, by a discharge across the face of the diamond between the needle electrode and the brass block on which the diamond is mounted. Without the quenched gaps in the circuit, the discharge would be a more or less continuous arc, overheating the diamond, and producing a dark deposit on its surface. The rate of drilling increases with the power input into the circuit until a limit is reached where the temperature of the diamond is too high and its surface takes on a frosty appearance. The drilling needle becomes red hot at its tip before this "frosting" point is reached and the reddening point of the electrode is used as a criterion in adjusting the power input to the circuit.

The secondary cone is formed by the action of a low-voltage spark in an electrolytic solution. The diamond is mounted on an insulating post in a shallow glass dish and enough of the electrolyte is used to fill the dish and just cover the diamond. The "drilling" electrode is a platinum-iridium needle that is lowered into contact with the bottom of the primary cone and rests with light pressure (around one fifth of a gram) on the diamond. A second electrode dips into the solution at some distance from the diamond.

When a low voltage (around 90 volts) is applied between the electrodes, sparking occurs at the tip of the drilling needle and a smooth-walled conical hole is formed in the diamond directly under the needle. The shape of the hole and the angle of its walls are controlled by the type of electrolyte used, while the hole size is controlled by the pressure of the needle against the diamond. The power input into the circuit is controlled by the depth of the solution covering the diamond and by the voltage applied.

The National Bureau of Standards method of making small diamond dies consists essentially of ten steps which combine electrical with some mechanical drilling. The die blank which is used in these operations has two plane parallel faces between which the die will be formed and a side window for viewing the progress of the drilling. These are cut on the diamond, using a rotating cast-iron lap with diamond powder as an abrasive. The cutting action of the lap is accelerated by the application of a high-voltage electric arc across the face of the diamond being cut.

Dies produced by the National Bureau of Standards method are claimed to have better wearing characteristics in service than those produced by purely mechanical methods. In mechanically drilled dies, holes are started in the top and bottom of the diamond by "bruting" or gouging the face of the diamond with a small diamond chip. The hole is drilled through the body of the diamond by "packing" it with a spinning steel needle charged with diamond powder, a sort of "star-drilling" process. These operations result in severe strains and minute fractures in the walls of the die cones, and although the magnitude of the strain resulting from mechanical drilling decreases with reduced load on the drilling needle and with the size of the diamond powder used, it is still present in most mechanically drilled secondary cones. Frequent failure by chipping at the intersection of the secondary and exit cones of dies so drilled is ascribed to weakening of the material by the mechanical treatment. Likewise, rapid wear of some dies at their initial size may be attributed to disruption of material, underlying the working surfaces of the dies, that has not been removed by sufficient polishing.

In contrast to the condition found in mechanically drilled dies, cones produced by either the high-voltage or the electrolytic drilling process show no strain in the surrounding material when examined under polarized light. The freedom from strain and fractures results in less wear as the die is used to draw wires.

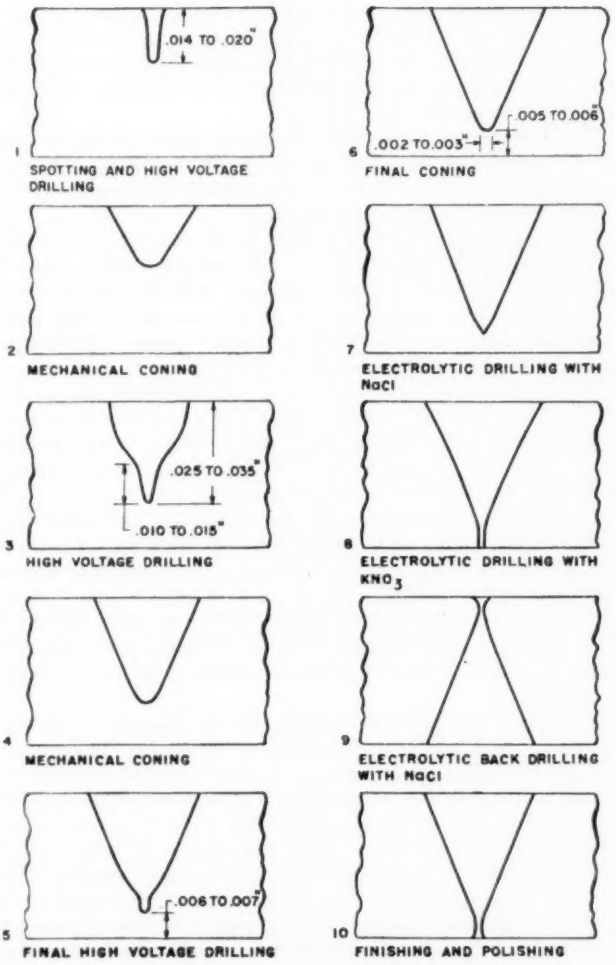


FIG. 15 THE TEN SUCCESSIVE STEPS IN THE NATIONAL BUREAU OF STANDARDS METHOD OF MAKING SMALL DIAMOND DIES

The electrical methods of die formation are therefore particularly adapted for small dies used in drawing wires, 0.0015 in. in diameter, or smaller.

It is said that the electric method requires no special skills or long training on the part of operators. Equipment is inexpensive and the drilling technique is simple making the work less tedious and more practicable for small as well as large-scale enterprise.

Research and Development

A NEW service in the form of the American Research and Development Corporation, Boston, Mass., was formed in June, 1946, to provide and encourage research and to aid in the development of small new businesses into companies of stature and importance.

A unique feature of the corporation is that its stock is owned by institutional as well as individual investors. The institutional group is composed of investment trusts, life insurance companies, and educational institutions and foundations.

The fundamental policy of the company is that its principal activities will consist of investigation and research with respect to new enterprises, processes, or products, and of furnishing capital to or purchasing securities of other companies princi-

pally engaged in the conduct or development of new enterprises, processes, or products.

There is no particular industry or group of industries in which the company proposes to concentrate its investments, nor is it limited as to geographical location.

The company will not itself engage directly in manufacturing or merchandising; and it is not interested in established enterprises which are in poor financial condition and require additional financing and new management.

Generally speaking, a project to be of interest to the company should demonstrate that research and development carried on to date indicate that the enterprise will be commercially practicable, that satisfactory profit potentialities exist, and that the competitive position is initially protected through patents or specialized knowledge and techniques.

These standards would generally preclude projects in the "idea" or "test-tube" stages. However, there may be unusually promising projects in these stages which would justify undertaking additional research and rendering to such projects both financial and technical assistance.

For success, the corporation must continue to receive and review outstanding new opportunities in all fields. Research in all fields will be constantly reviewed to insure a balanced program of investments, to show trends of interest, and to indicate where future technical advances will prove most valuable.

In order to assure diversification, the company may not invest more than 10 per cent of its capital and surplus in any single enterprise.

The corporation has no formula for the financing of a new project. Each represents an individual problem. As a matter of general policy, it is planned to take an equity position in order to share in the ownership and growth of promising new enterprises. Further details governing types of securities, interest, royalties, and other considerations, are carefully worked out in every case to provide a sound financial structure with proper recognition of the interests of all parties concerned.

It is the plan of the corporation also to make business counsel available to those new enterprises in which it has a financial stake. The corporation usually will be represented on the Board of Directors, will assist in the procurement of personnel for key positions, and will endeavor to make available the best possible technical assistance.

Thus far, a total of $500,000 has been invested in three different types of companies. For example, one of the concerns, Circo Products Company, Cleveland, Ohio, is a typical small business, ably managed, and in business for several years. It manufactures and sells vapor degreasing units used in machine shops and repair shops for the removal of grease from metal parts.

Recently the company has developed a small degreasing unit specifically designed to remove residual old grease and sludge from automobile transmissions and differentials. The unit resembles, in general appearance, a common paint-spray gun and consists essentially of a small can of solvent in which a thermostatic electric heater is immersed.

The company proposes to distribute these degreasing units to automotive service stations and to sell the special solvents in cans under company trade-mark. Initial distribution of units of this type has met an enthusiastic response from consumers and from service-station operators.

The three companies selected for investment were chosen from more than 300 projects submitted, and are typical of the size in which the venture-capital group is interested. They will do a sales volume probably ranging from $500,000 to $2,000,000 per year, and the financing involved is well within the 10 per cent limitation of the company.

Among the officials of the American Research and Development Corporation are Georges F. Doriot, member A.S.M.E., president; Frederick S. Blackall, Jr., director at large A.S.M.E., and Ralph E. Flanders, Honorary Member A.S.M.E., directors; and Karl T. Compton, member A.S.M.E., and Jerome C. Hunsaker, Honorary Member A.S.M.E., board of advisors.

Microscopic Wire

A STRAND of tungsten wire so microscopic that 1000 ft of it reeled on a bobbin appear invisible to the unaided eye has been manufactured by the Westinghouse Lamp Division, Bloomfield, N. J. The wire, 0.00018 in. in diameter, is said to be the smallest produced in the 40-year history of wire drawing in the tungsten department of the company. It was calculated that a 20-layer stack of the wire would equal the thickness of a sheet of newsprint and that a pound of it would stretch single strand for 950 miles.

The wire was processed on special assignment for the Bell Telephone Laboratories. It is required for an amplifying tube.

To produce the 0.00018-in. wire, it was given a special chemical bath after being drawn through the finest industrial diamond dyes available to fabricate tungsten filament wire for electric lamps and electronic tubes. Since obscure wire sizes are impractical to measure mechanically, engineers computed the average diameter by weighing an eight-inch-long strand of the wire on a scale balance sensitive enough to record the weight of a pencil mark on a postage stamp.

FIG. 16 THE LARGEST SPHERICAL ROLLER BEARING EVER BUILT IN THE UNITED STATES IS NOW BEING MACHINED AT SKF INDUSTRIES, INC., IN PHILADELPHIA, PA.

(One of the 5100-lb giants destined for the supercalender of the Kimberly-Clark paper mill in Niagara, Wis., is shown being ground. Four feet in diameter, the bearing is just 1,500,000 times larger than the company's smallest antifriction bearing and is designed for a basic load in excess of 4,000,000 lb.)

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

The Industry-Ordnance Team

THE INDUSTRY-ORDNANCE TEAM. By Levin H. Campbell, Jr. Whittlesey House, McGraw-Hill Book Co., Inc., New York, N. Y., 1946. Cloth, 6 × 8⅞ in., 461 pp., illus., $5.

REVIEWED BY DEXTER S. KIMBALL[1]

THIS valuable and instructive book is the story of the phenomenal joint achievement of American industry and the Army Ordnance Department in producing and delivering fighting equipment to our armed forces and our many allies. As chief of the forty-billion-dollar ordnance program in World War II, General Campbell directed the design, production, delivery, and maintenance of more than 2000 major pieces of fighting equipment and 700,000 different kinds of spare parts to keep this equipment in combat condition. He therefore speaks with authority and deep feeling.

The book is valuable for three particular reasons. First it tells in some detail how the seemingly impossible task of combining the very accurate requirements of modern ordnance with the mass-production methods of modern industry so as to produce the staggering quantities of guns, ammunition, tanks, and supplies in the quickest possible time was accomplished. In retrospect it appears that the impossible *was* accomplished and furthermore the successful co-operation between the Ordnance Department and industry indicates that, as it was the basis of our survival in this war, it must be the basis of any security program for the future.

Second the book lists in some detail the character and volume of the armament produced as well as the methods by which industry was organized and integrated for the great effort. While much of the discussion is statistical in character, it is, in the opinion of the reviewer, of greatest importance for it records in concise form what was produced and the general arrangements by which it was manufactured and distributed. Efforts of this magnitude are consummated only through great labor and against many great difficulties and often in spite of strong differences of opinion. This is well brought out in the chapter on Ordnance and the War Production Board. The story of the development of the War Production Board from small beginnings to the efficient organization that it finally became is quite typical of most of our war effort. It is to be hoped that a record similar to the book under review will be made of every major war organization.

Thirdly, General Campbell in the concluding chapter records his convictions, based upon his experience, as to what our future course should be assuming that wars have not ceased to menace us. He states, "Our experience in the Second World War leads us to believe that the nation which is strongest industrially and which can apply its industrial power quickly and with maximum effectiveness will be the certain winner of any future conflict. We should begin now to devote more time and attention in our academies and service schools to supply, maintenance, logistics, the potentialities of weapons, the best methods for the use of weapons, and all the thousand and one intricate facets which go to make up first of all the industrial might of a nation and secondly, the application of this industrial might to battle." This is indeed strong medicine, yet what thoughtful man viewing the trend of world events can fail to realize that eternal vigilance is the only hope of freedom, and that this nation should never again be caught as unprepared as we were at the beginning of the great conflict just ended. Or as "Teddy" Roosevelt expressed it, "Walk softly but carry a big stick."

[1] Ithaca, N. Y. Hon. Mem. A.S.M.E.

Laboratory Manual in Metallography

LABORATORY MANUAL IN METALLOGRAPHY. By John F. Eckel and Robert J. Raudebaugh. McGraw-Hill Book Co., Inc., New York, N. Y., 1946. Paper, 8 × 10¾ in., viii and 344 pp., $4.50.

REVIEWED BY PETER E. KYLE[2]

IN the conduct of laboratory work in metallography, one of the most important points to emphasize is the need for keeping a record of the methods used in the experiment, the observations made, and the interpretation of the results. This manual is a very excellent one to help the student accomplish these purposes. It provides data sheets for recording the identification of the sample being studied, its treatment, and all of the pertinent data on the etch, magnification, and camera setting used in the making of the photomicrograph. The experiments for which the manual is designed include polishing and photographic methods, cast metals, hot- and cold-working effects, constitutional diagrams, heat-treatment including age-hardening, powder metallurgy, and general experiments on steels, copper alloys, zinc alloys, aluminum and magnesium alloys, lead alloys, and bearing metals.

[2] Professor of Metallurgy, Cornell University, Ithaca, N. Y. Mem. A.S.M.E.

Job Evaluation

JOB EVALUATION. By Forrest H. Johnson, Robert W. Boise, Jr., and Dudley Pratt. John Wiley & Sons, Inc., New York, N. Y., 1946. Cloth, 5½ × 8⅜ in., 288 pp., charts, tables, $3.75.

REVIEWED BY JOHN A. PATTON[3]

THE book represents a worthy addition to the not too lengthy list of works on the subject of job evaluation. Certainly it is well written and presents its story in a completely new form.

However, it is that new form which undoubtedly limits the understanding of the book's message to those who are reasonably familiar with job evaluation. The background explanation of job evaluation is quite brief and thus may also limit the group for which the material is of greatest value.

While many more people are somewhat familiar with job evaluation today than before the war, I do not believe it is wise to step into the consideration of building a plan before discussing what has been done in the field. Of course, the authors stated that they intended no comparison of their methods with others. However, I still feel that such a comparison is advantageous when a particular plan is to be put over and that is really what the authors intend to do, despite their claim that they are not suggesting any revolutionary methods.

[3] President, John A. Patton Management Engineers, Inc., Chicago, Ill.

One other criticism of the book is its discussion of the establishment and maintenance of a job-evaluation department from the standpoint of a very large company. It thereby leaves much to the individual in the development of plans for his own organization.

Particularly enlightening parts of the book are the job-description forms and the excellent discussions and interpretations of the various factors employed in job- and salary-evaluation plans. With the exception of the section regarding special factors, the discussion of building the job-evaluation plan is also an excellent treatise, very clearly worded and well presented.

In summation of the book's over-all value, it is sufficient to state that it is a well-written text which fills a definite gap in the job evaluation material previously available. Thus it should be extremely interesting to many despite the limitations of its reader scope.

Books Received in the Library

AGE-HARDENING OF METALS. American Society for Metals, Cleveland, Ohio, 1940. Cloth, $5\frac{1}{2} \times 9$ in., 448 pp., illus., diagrams, charts, tables, $5. Twelve papers presented at a symposium on precipitation hardening are reprinted in this volume. Written for specialists, these papers discuss precipitation-hardening characteristics and effects with respect to a variety of alloys. The first paper notes the discovery and early investigation of the effect, while the final paper discusses the actual mechanism of precipitation from solid solution and develops the general theory of age-hardening.

ANNUAL REPORT ON THE PROGRESS OF RUBBER TECHNOLOGY, Vol. 9, 1945, edited by T. J. Drakeley, published by W. Heffer & Sons, Ltd., Cambridge, England, for the Institution of the Rubber Industry, London. Paper, $7\frac{1}{4} \times 9\frac{1}{2}$ in., 117 pp., tables, 12s, 6d; (to members, 4s, 6d). This report, as the previous ones, contains concise surveys of developments in the rubber field accompanied by lists of references. Topics dealt with in the present report include the planting and production of raw rubber substances, the properties and uses of latex and finished rubber, compounding ingredients, machinery and processing methods, the important classes of rubber products, synthetic rubber, cellular rubber, and miscellaneous fibers and textiles.

APPLIED PLASTIC PRODUCT DESIGN. By R. L. Davis and R. D. Beck. Prentice-Hall, Inc., New York, N. Y., 1946. Cloth, $6 \times 9\frac{1}{4}$ in., 285 pp., illus., diagrams, charts, tables, $6. Special design considerations are emphasized in this outline of fundamentals for those who wish to take full advantage of the possibilities. Mold practice, thread formation, inserts, decoration of molded parts, extrusion methods, laminated parts, and parts made from sheets, rods, and tubes are dealt with in separate chapters. Economic aspects and the properties of plastics are briefly discussed and there is a glossary of technical words.

ATOMIC THEORY for Students of Metallurgy (Institute of Metals Monograph and Report Series No. 3.) By W. Hume-Rothery. Institute of Metals, London, England, 1946. Cloth, $5\frac{1}{2} \times 8\frac{1}{2}$ in., 286 pp., illus., diagrams, charts, tables, 7s, 6d. This book was written primarily to provide the general background of atomic theory required for the effective understanding of the electron theory of metals. The first half of the book presents this necessary background on a thorough mathematical basis, while the second half develops the metallurgical aspects with emphasis on the properties of metals, conductivity, emission, and magnetism, for which the underlying theories provide a direct explanation. Intended for advanced students and research workers in metallurgy, much of the subject matter should also be of interest to chemists and physicists.

AUDELS OIL BURNER GUIDE. By F. D. Graham. Theodore Audel & Co., New York, N. Y., 1946. Cloth, $4\frac{3}{4} \times 6\frac{1}{2}$ in., 364 pp., illus., diagrams, charts, tables, $1. The purpose of this book is to provide a source for an understanding and a practical working knowledge of the theory, construction, installation, operation, testing, servicing, and repair of all types of oil burners, domestic and industrial. The book is profusely illustrated, with additional help in the form of electrical hookups (wiring diagrams) of all automatic-control systems. A considerable part of the text is in question-and-answer form.

Bibliography of INDUSTRIAL ENGINEERING AND MANAGEMENT LITERATURE to January 1, 1946. By R. M. Barnes and N. A. Englert. Fifth edition. Wm. C. Brown Co., Dubuque, Iowa. Paper, $8\frac{1}{2} \times 11$ in., 136 pp., $3. Part 1 of the fifth edition of this bibliography, revised to January 1, 1946, contains some 1200 titles of books and bulletins in the general field of management published in the last 30 years. The second part lists over 3000 articles and papers on motion and time study and related subjects. Both lists are alphabetically arranged by author. There are also a detailed classification of the articles and papers by subjects and an alphabetical list of the 145 magazines and journals from which articles were taken.

COSMIC RADIATION, Fifteen Lectures, edited by W. Heisenberg; translated by T. H. Johnson. Dover Publications, New York, N. Y., 1946. Cloth, $6 \times 9\frac{1}{2}$ in., 192 pp., illus., diagrams, charts, tables, $3.50. The fifteen lectures collected in this book were presented in Germany in 1941 and 1942. They are broadly grouped as follows: An introductory review of the present state of knowledge of cosmic radiation; two papers on the cascade theory; nine papers dealing with mesons; two papers on nuclear particles; and one paper on geomagnetic effects. Although the work of several authors, the material is well integrated with cross references and a consistent notation. A general view is given of recent accomplishments and outstanding problems in this branch of physics. There is a general index.

DIESEL OPERATION AND MAINTENANCE. By O. L. Adams, Sr. Prentice-Hall, Inc., New York, N. Y., 1946. Cloth, $6 \times 9\frac{1}{4}$ in., 366 pp., illus., diagrams, charts, tables, $5. Emphasizing the fundamental aspects of Diesel-engine operation, this practical book considers in detail the various working parts, including the fuel and lubrication systems, as well as the general working principles. The origin of the major engine problems is identified and traced to these fundamental principles. Standard maintenance, inspection, and repair practices are given, including trouble-shooting instructions for determining causes of engine failures and diagnosing fuel and lubricating problems.

FLIGHT TESTING, Conventional and Jet-Propelled Airplanes. By B. Hamlin. The Macmillan Co., New York, N. Y., 1946. Cloth, 8×11 in., 147 pp., illus., diagrams, charts, tables, $5. Standardized methods are given for the analysis and reduction of flight-test data to standard conditions; in Part 1 for conventional airplanes, and Part 2 for jet-propelled airplanes. The book also covers basic flight-testing formulas, data required and methods for acquiring them, necessary instrumental vibrations, and explanations of essential aerodynamic theories including the theory and general characteristics of turbojet engines. All necessary terms and symbols are carefully defined or explained.

HEAT TREATMENT OF METALS, a Series of Educational Lectures presented to members of the Los Angeles Chapter of the Society. By E. Brooker and others. American Society for Metals, Cleveland, Ohio, 1946. Cloth, $6 \times 9\frac{1}{4}$ in., 178 pp., illus., diagrams, charts, tables, $3. The series of ten lectures reprinted in this volume cover various aspects of the general subject, including induction heating, isothermal transformation in steel, two papers on the treatment of light metal alloys, and three on the theory and practical applications of hardenability. The first lecture briefly defines heat-treating methods and gives examples of particular applications.

Industrial Relations Monograph No. 12, UNIONIZATION OF PROFESSIONAL ENGINEERS AND CHEMISTS, by H. R. Northrup. 52 pp., $1.50. Industrial Relations Monograph No. 13, RECONVERSION IN INDUSTRIAL RELATIONS, by B. M. Stewart and W. J. Couper. 72 pp., $1.75. Industrial Relations Counselors, New York, N.Y. 1946, paper, $6 \times 9\frac{1}{4}$ in. No. 12 of this series of studies examines the union movement among engineers and chemists of professional status. Existing unions, the reasons for unionization, the attitude of the professional societies, Labor Relations Board decisions, and collective-bargaining activities are discussed in a brief, factual manner. No. 13 takes up the human aspect of reconversion, evaluating the wartime gains and losses in industrial relations, setting forth some of the pressing current problems, and discussing management attitudes and broad matters of policy.

INDUSTRIALIZATION OF LATIN AMERICA, edited by L. J. Hughlett. McGraw-Hill Book Company, Inc., New York, N. Y. and, London, England, 1946. Cloth, $6 \times 9\frac{1}{4}$ in., 508 pp., illus., diagrams, maps, tables, $5. Thirty business leaders of the United States and Latin America discuss some seventeen major industries, giving a comprehensive, practical picture of the Latin American industrial system. Trade potentialities are interpreted and evaluated, economic trends affecting manufacturing activities are analyzed, and the direction of probable future developments is forecast. Photographs, diagrams, maps, and tables add to the practical aspect of the book.

Introduction to MATHEMATICAL STATISTICS. By P. G. Hoel. John Wiley & Sons, Inc., New

York, N. Y., Chapman & Hall, London, England, 1947. Cloth, $5^1/_2 \times 8^1/_2$ in., 258 pp., diagrams, charts, tables, $3.50. Sampling inspection, design of experiments, testing of statistical hypotheses, analysis of variance, sequential analysis, and nonparametric methods of analysis are important topics dealt with in this comprehensive introduction to modern statistical methods. The first seven chapters of the book are largely concerned with the theory of certain classical large-sample methods arranged according to the number of variables. In the last five chapters some important small-sample methods are considered along with other modern developments.

JIGS AND FIXTURES FOR MASS PRODUCTION. By L. A. Bryant and T. A. Dickinson. Pitman Publishing Corporation, New York, N. Y., and Chicago, Ill., 1947. Cloth, $6 \times 9^1/_4$ in., 222 pp., illus., diagrams, tables, $3.50. This practical book describes the design and construction of the various types of jigs and fixtures, covers the subjects of plastics, pneumatics, and hydraulics as applied to tooling, and considers the important recent developments in tooling procedures such as the master tooling dock. Particular attention is given to assembly tooling on which large-scale production so largely depends. There is a glossary, and a list of tool symbols is suggested for a tool-identification code.

KINETIC THEORY OF LIQUIDS. By J. Frenkel. Oxford University Press, New York, N. Y.; Clarendon Press, Oxford, England, 1946. Cloth, $6^1/_4 \times 9^1/_2$ in., 488 pp., diagrams, charts, tables, $13. Considering liquids to be more closely akin to solids than to gases, the author discusses, in the early chapters, the types of disorder in the solid state, purely thermal displacements of atoms, the motion of interstitial atoms and ions, and many types of transition from an ordered to a disordered state as fundamentals of the problem of transition to the liquid phase. Later chapters deal with the specific heats of liquids, diffusion in liquids, surface and allied phenomena, and various properties of solutions and high-polymeric substances.

MACHINE DESIGN. By L. J. Bradford and P. B. Eaton. Fifth edition. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, London, England, 1947. Cloth, $5^1/_2 \times 8^1/_2$ in., 283 pp., illus., diagrams, charts, tables, $3.25. Beginning with fundamental definitions and considerations, this textbook proceeds to cover various basic machine elements, such as bearings, shafts, gearing, and frames. In the interests of effective grounding in this subject, special machines, shortcut formulas, and graphical methods have been given little consideration in order to emphasize the generalized aspects with their fundamental equations. Additions to the new edition relate principally to the fatigue of metals, friction and lubrication, and design of aluminum parts.

MACHINE-SHOP ESTIMATING. By W. A. Nordhoff. McGraw-Hill Book Co., Inc., New York, N. Y., 1947. Cloth, $5^1/_2 \times 8^1/_4$ in., 486 pp., illus., diagrams, charts, tables, $6. A scientific basis is provided for evaluating the performance of machine-shop operators by showing how to estimate the time that should be required to perform a job. The book lists all of the elements of operations performed in an average machine shop and establishes reasonable time values for their execution by the average operator. All machine operations are fully described; tables supply machinery elements which are generally variable; and sample estimates are shown for practical demonstration purposes.

MANUFACTURING PROCESSES. By M. L. Begeman. Second edition. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, London, England, 1947. Cloth, $5^1/_2 \times 8^1/_2$ in., 626 pp., illus., diagrams, charts, tables, $5. Beginning with foundry practice and ending with grinding wheels and abrasives, this volume presents the technical fundamentals of the important manufacturing processes, discusses engineering materials, and describes the modern machine tools necessary for processing these materials. New chapters in the present revision deal with special casting methods, powder metallurgy, hot-forming and cold-forming of metals. The material on welding and plastic molding has been extensively revised. There is also a chapter on inspection and gaging practice.

MATRIX AND TENSOR CALCULUS with applications to Mechanics, Elasticity, and Aeronautics. (Galcit Aeronautical Series.) By A. D. Michal. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, London, England, 1947. Cloth, $6 \times 9^1/_4$ in., 132 pp., diagrams, tables, $3. Matrix calculus and tensor calculus are dealt with separately in the two parts of this book. The minimum of mathematical concepts is presented in the introduction to each part, with the more advanced mathematical ideas being developed as needed in connection with the material on applications. Although the emphasis is on aeronautical and mechanical applications, such as vibrations, aircraft flutter, elasticity, hydrodynamics, and fluid mechanics, the purpose is to provide a working knowledge of use in many technical fields.

MECHANICS OF MATERIALS. By P. G. Laurson and W. J. Cox. Second edition. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, London, England, 1947. Cloth, $5^1/_2 \times 8^1/_2$ in., 422 pp., illus., diagrams, charts, tables, $4. With the needs of the student in mind, this text presents a full treatment of the fundamentals needed for a minimum course. Additional chapters on the more advanced aspects of beam and column analysis, stresses and deflections, and loaded connections, are included to provide fuller coverage for those who wish it. The physical behavior of stressed bodies has been emphasized throughout as well as the mathematical expression of this behavior. More than 600 graded problems are provided.

PRODUCTION AND PROPERTIES OF PLASTICS. By S. L. Kaye. International Textbook Co., Scranton, Pa., 1947. Cloth, $6 \times 9^1/_4$ in., 612 pp., illus., diagrams, charts, tables, $5. Presenting a complete survey of the field, the author discusses the various types of plastics, the selection of raw materials, treatment processes, design of molds, application of heat and pressure, and finishing operations in the production of plastic articles. Inspection, testing methods, and practical applications are described, and the author has included numerous shop hints and procedures from practical experience. There is also a chapter on cost estimates for plastic articles.

RAYON AND SYNTHETIC FIBER INDUSTRY OF JAPAN. By H. W. Rose. Textile Research Institute, New York, N. Y., 1946. Cloth, 6 $\times 9^1/_4$ in., 340 pp., illus., diagrams, charts, tables, $6. This publication presents the information gathered on the subject of rayon by the textile mission to Japan. It contains details of rayon companies and plants, figures on capacity and production, and considerable technical material on synthetic-fiber processes. Separate chapters deal with raw materials, patents, research, and education. Illustrative diagrams and photographs are included, and there is a brief glossary of general and technical Japanese terms.

REFRIGERATION, Theory and Applications. By H. G. Venemann. Second edition. Nickerson & Collins Co., Chicago, Ill., 1946. Cloth, $6 \times 9^1/_4$ in., 336 pp., illus., diagrams, charts, tables, $4. The refrigerating field is broadly covered. The several chapters deal with thermodynamic fundamentals, various refrigerants, the important mechanical parts and their operation, and practical information on plant operation. Particular attention is paid to automatic controls, the analysis of actual plant performance, and estimating and accommodating plant loads. The final chapter discusses specifications for a refrigeration plant, and a group of 12 supplementary charts are in a pocket inside the back cover.

RESISTANCE OF MATERIALS. By F. B. Seely. Third edition, John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, London, England, 1947. Cloth, $4^1/_2 \times 8^1/_2$ in., 486 pp., illus., diagrams, charts, tables, $4. Part 1 of this standard text is concerned with the generalized basic aspects of the subject; the main problem is the determination of the relationships between the loads acting on a member and the resulting stresses and deformations in the member. Part 2 deals with more specialized topics such as particular kinds of stresses or structural members which may be dealt with independently. The emphasis throughout is on the engineering significance of the subject, with consideration given to altered conditions resulting from recent technological developments.

SERVOMECHANISM FUNDAMENTALS. By H. Lauer, R. Lesnick, and L. E. Matson. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1947. Cloth, $6 \times 9^1/_4$ in., 277 pp., diagrams, charts, tables, $5. The purpose of this book is to introduce the engineering student and the practising engineer to the principles underlying the theory of servomechanisms. It offers a complete derivation of the basic properties of servocontrol devices and systems, and their direct relation to the simple physical principles that govern their operation. Working formulas, curves, and diagrams are also given, together with many practical examples and problems. Particular emphasis is placed on the transient analysis of simple servomechanisms.

STEAM POWER STATIONS. By G. A. Gaffert. Third edition. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1946. Cloth, 6 $\times$ 9 in., 613 pp., illus., diagrams, charts, tables, $5.50. Steam-power-plant machinery is covered from the standpoint of construction of the various types of equipment, their performance characteristics, economics, and integration in the complete plant. The new edition of this standard textbook has been revised and includes recent information on modern equipment, such as steam turbines, condensing equipment, steam-generating units, and mercury-steam installations. The material has been strictly confined to the mechanical-engineering features, with emphasis on design and construction.

SYMPOSIUM ON MATERIALS FOR GAS TURBINES, 49th Annual Meeting, American Society for Testing Materials, June 24–28, 1946. American Society for Testing Materials, Philadelphia, Pa. Paper, 6 $\times$ 9 in., 199 pp., illus., diagrams, charts, tables, $3. (A.S.T.M. members, $2.25.) The first five papers in this group deal directly with researches on the subject carried

out over the last few years: heat-resisting metals for gas-turbine parts; high-temperature alloys for aircraft turbosuperchargers and gas turbines; chromium-base alloys; metallurgy of high-temperature alloys used on current gas-turbine designs; alloys and ceramic materials for high-temperature service. The succeeding three papers are of related interest and deal with the corrosion resistance of iron-nickel-chromium alloys, the comprehensive properties of aluminum-alloy sheet, and the tensile and creep strengths of some magnesium-base alloys, all at elevated temperatures.

TABLES OF SPHERICAL BESSEL FUNCTIONS, Vol. 1, prepared by the Mathematical Tables Project, National Bureau of Standards. Columbia University Press, New York, N. Y., 1947. Cloth, 8 × 10¾ in., 375 pp., tables, $7.50. In the theoretical analysis of wave motion, solutions of various co-ordinate systems are necessary, and in certain ones Bessel functions are involved having orders equal to one half an odd integer. The present volume provides tables to seven or more significant figures for the spherical Bessel functions of orders $\pm(n + 1/2)$ where $n = 0$ to 13 with an interval of 1, and for a range of X from 0 to 10 with intervals of 0.01 and from 10 to 25 with 0.1 intervals. The customary detailed explanatory introduction is included, and a list of the previous publications of the series is appended.

THEORY OF FUNCTIONS OF REAL VARIABLES. By L. M. Graves. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1946. Cloth, 5¾ × 9 in., 300 pp., diagrams, $4. This book offers a compact presentation of the theorems and methods which are fundamental for research in analysis. The more basic and generally useful parts of the theory of functions of real variables are treated in detail, together with many results not usually found in standard treatises on the subject, such as some of the theorems on implicit functions, differential equations, and Lebesgue and Stieltjes integrals. The more advanced material is indicated by stars for omission on first reading.

USE OF RESEARCH BY PROFESSIONAL ASSOCIATIONS IN DETERMINING PROGRAM AND POLICY. By E. L. Brown. Russell Sage Foundation, New York, N. Y., 1946. Paper, 6 × 9 in., 39 pp., $0.25. The weaknesses of program and policy determination for large professional associations by individuals or conference table methods are briefly discussed, and the use and value of research for these activities are shown by examples in actual association work dealing with professional training, salary and personnel practices, and the structure and function of the associations themselves.

VAN NOSTRAND'S SCIENTIFIC ENCYCLOPEDIA, Second edition. D. Van Nostrand Company, New York, N. Y., 1947. Cloth, 7 × 10½ in., 1600 pp., illus., diagrams, charts, tables, maps, $10. Considerably revised, this comprehensive reference work presents in detail over 10,000 separate subjects dealing with the principles and applications of the physical sciences, medicine, and technology, from aeronautics to zoology. The presentation of each topic, beginning with a simple, nontechnical definition and progressing to the more advanced phases, is helpful to the general reader. In addition to the customary cross-references, all terms in the main alphabetical list are printed in heavy type wherever they appear in the context. Diagrams, sketches, and data tables are included wherever they will be of particular use.

A.S.M.E. BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code may communicate with the Committee Secretary, A.S.M.E., 29 West 39th St., New York 18, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are then sent by the Secretary of the Committee to all members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and is passed upon at a regular meeting.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and published in MECHANICAL ENGINEERING.

Following is a record of the interpretations of this Committee formulated at the meeting of February 14, 1947, and approved by the Council on March 26, 1947

CASE No. 1038 (Reopened)

(Special Ruling)

Inquiry: For dished heads convex to the pressure as shown in Fig. U-18(*c*), Par. U-73(*c*) indicates that this construction is permissible on vessels covered by Par. U-70, since the head joint may be regarded as of the lap type. Is this construction also permissible for pressure vessels covered by Par. U-69?

Is it permissible to use shorter lengths of flange (skirt) in dished heads concave to pressure as shown in Fig. U-18(*a*) and convex to pressure as shown in Fig. U-18(*c*) than now required by Par. U-75?

Reply: It is the opinion of the Committee that the intent of the Code will be met and vessels may be stamped with the symbol if the following rules are met:

(1) The construction shown in Fig. U-18(*c*) may be used for pressure vessels under Par. U-69 provided the pressure is on the convex side only and the shell thickness does not exceed ⅝ in. The throat of the fillet weld shall be not less than the thickness of the shell.

(2) For the construction shown in Fig. U-18(*a*) and (*c*), the heads shall have a skirt (flange) not less than 1½ in. long, except that when the nominal head thickness is ½ in. or less, the skirt (flange) shall be not less than 3 times the thickness of the head.

Attention is called to the construction of Fig. U-18(*b*), where the length of skirt (flange) is governed by the requirements of that figure plus the requirement in Par. U-73(*a*) that the surface overlap for a lap type joint shall be at least 4 times the thickness of the shell.

CASE No. 896 (Reopened)

Case No. 896 has been tentatively revised as indicated below and is published only for the purpose of securing comments. The final revision of this Case will not become effective until after comments have been received and notice of adoption appears in a subsequent issue of MECHANICAL ENGINEERING. Comments should be submitted to the Secretary of the Boiler Code Committee, A.S.M.E., 29 West 39 St., New York 18, N. Y. within 30 days after publication of this issue.

With the revision of Case No. 896, Case No. 828 will be annulled.

Inquiry: Is it permissible, under the rules of Section VIII of the Code, to construct fusion-welded pressure vessels of alloy clad material complying with Specifications SA-263, SA-264, and SA-265 or with corrosion-resistant linings welded to the walls of vessels made of approved materials?

Reply: It is the opinion of the Committee that fusion-welded pressure vessels may be constructed of alloy-clad plate material complying with the above specifications or of material complying with a specification approved for welding to which a corrosion-resistant lining is attached by welding, or of a combination of such two constructions provided that all requirements in Section VIII covering design, welding and tests for the class of service for which the vessel's are intended are complied with, as well as the following additional requirements:

(1) It is expected that vessels of the type covered by these rules will be used to hold liquids and gases corrosive to ordinary materials, but the selection of a material suitable for the vessel's contents and the determination of corrosion allowance is not covered by these rules.

It is recommended that users assure themselves by appropriate tests or otherwise, that the cladding or lining material selected and its heat-treatment following fabrication are suitable for the service intended.

Where service data are not available, the procedure of Par. U-11(**b**) shall be followed.

(2) The base plate material shall be in accordance with an approved plate steel specification whether clad or lined.

(3) The weld shall be completed before radiographing where radiography is required except that when the thickness of the steel base plate only is used in the design calculations and the joint is made either by first removing a narrow strip of cladding or by leaving a gap between the lining sheets, then welding the base plate and subsequently inserting a strip of the corrosion resistant material welded along both edges to complete the cladding or lining, the weld in the base plate may be radiographed before the strip is added.

When a joint that is required to be radiographed is covered by weld deposit, the radiographing shall be done after such deposit is completed.

(4) When it is intended to protect portions of the base metal, welds in the base metal, flange faces, etc., against corrosion by layering with weld deposit, the welding procedure and each operator shall be qualified as follows:

Weld deposit shall be layered on a base plate approximately $^{5}/_{16}$ in. thick and about 5 in. × 8-10 in. long; position of the plate during deposition of the weld to be the same as that used in production. The weld metal shall be deposited to form a 6-in long pad in the middle of the plate by building up beads in a longitudinal direction. The pad shall be machined smooth and to a total thickness of $^{3}/_{8}$ in. Following welding, the test plate shall be subjected to the same heat-treatment as will be required for the vessel. Two bend tests shall be cut longitudinally and bent as guided-bend tests with the alloy surface in tension. The requirements of Par. Q-109 of Section IX of the Code shall be met.

When deposits of this type are qualified under (9), qualification under this paragraph is not required.

(5) The types of joints and welding procedure used shall be such that steel weld metal shall not fuse into the corrosion-resistant layer and the depth of the corrosion-resistant bead shall be kept to a minimum.

(6) Fillet welds may be used under the provisions of Par. U-70, provided the deposited weld metal meets the requirements of (7) and (4).

(7) It is important that the completed welds where exposed to the contents of the vessel have a corrosion-resistant property substantially equal to that of the cladding or lining materials. Such welds shall preferably be made using filler rods that will deposit metal of substantially the same analysis as the material joined. However, weld metal of a dissimilar analysis may be used if in the opinion of the manufacturer a physically better deposit can be obtained and the user and the inspector are satisfied that the corrosion resistance will be sufficient for the intended service.

Clad Material to Specifications SA-263, SA-264, or SA-265

The following requirements (8) to (13), inclusive, apply to continuously bonded clad steel plates made to Specifications SA-263, SA-264, or SA-265.

(8) All clad steel plates shall show a minimum shear test of 20,000 psi when tested in the manner described in the specification. One shear test shall be made on each rolled plate and results reported by the mill.

(9) (*a*) When a joint is to be made by a procedure requiring that corrosion-resistant weld metal be laid upon base weld metal, the welding procedure qualification and vessel test plates shall be made from clad material of the same grade as used in the vessel, and operator qualification shall be made on clad material of the same "0" numbers given in Table Q-5 for base metal, and of the same "P" numbers, given in Table Q-5 for cladding and weld rod as used in the vessel. All of the cap tests shall include duplicate bend specimens, one with the clad surface in tension and the other with the clad surface in compression, and shall meet the requirements of Section IX for the class of construction (Pars. U-68, U-69, or U-70) involved. When the cladding material is not listed in Table Q-5, both qualifications shall be made on material of the same grade as used in the vessel.

(*b*) When a joint is made by any other procedure than (*a*), the qualification tests may be made as in (*a*) or the welding procedure and operator qualifications may be made separately on the base metal to meet the requirements of Section IX, and the cladding materials to meet the requirements of (4).

The all-weld metal tension bar required by Par. U-68(*d*) shall contain no cladding on the gage length. When not enough base weld metal is available for the standard 0.505 bar, it may be omitted.

(10) Vessels constructed of Specification SA-263, Grade D, type 430 modified, composite material shall be limited to a service temperature of 800 F maximum. In no case shall the service temperature for vessels constructed of composite materials exceed the limiting temperature given in Table U-2 or Table U-3 for either the backing or facing material used.

Stress relief shall be mandatory for vessels constructed of chromium steel clad material complying with Specification SA-263.

Because of the danger of cracking when welding composite plates of chromium steel clad material complying with Specification SA-263 with straight chromium steel rods, radiographic examination of all main seam welds is mandatory for Pars. U-68, U-69, U-200, and U-201 vessels, while the completed alloy welds for Par. U-70 vessels shall be carefully examined for cracks. When austenitic rods are used on chromium steel clad material for Par. U-69 vessels, radiographing of the welds is not required.

(11) (*a*) For Pars. U-68, U-69, and U-70 vessels the full thickness of the composite plate made to Specifications SA-263, SA-264, and SA-265 may be used in design calculations for all classes of construction where corrosion is not expected, provided the joints are made by depositing corrosion-resistant weld metal on the base metal weld to restore the cladding.

(*b*) For Pars. U-200 and U-201 vessels, and for other Code vessels when corrosion is expected, or when for any reason it is preferred not to include the cladding as a strength element, the design shall be based upon the total thickness of cladding specified. Reasonable excess thickness of the actual cladding may be considered to be an equal thickness of base material in applying Code rules. Inserted strips, if used, to restore cladding at joints shall be of a thickness equal to that of the nominal minimum thickness of cladding specified for the plates, backed, if necessary, with corrosion-resistant weld metal deposited in the groove to bring the insert flush with the surface of the adjacent cladding.

(12) The allowable stress shall not exceed the values given in Table U-2 for the grade of steel used for the base material.

(13) Where corrosion of the liner material is expected, additional liner metal thickness should be provided. In such cases the thickness added for corrosion shall be removed from the clad face of all tensile bars before testing.

Applied Linings

The following requirements (14) to (19), inclusive, apply to corrosion-resistant linings welded to the walls of vessels by any process or method that does not result in material that will meet all of the requirements for material furnished under Specifications SA-263, SA-264, and SA-265, including (8) above.

(14) The lining shall be any weldable quality metallic material which is expected to meet the requirements of (1).

(15) Attachment may be by means of strip, plug, resistance or equivalent process welds. Deposited weld metal where exposed to the contents of the vessel shall have satisfactory corrosion resistance for the intended service.

(16) The welding procedure to be used in attaching a liner to a vessel shall first be qualified by making sample welds which shall be sectioned, polished, and etched. Each operator shall make such a procedure qualification test. Visual examination of the cross section shall show complete fusion over the entire line of contact of the weld between the liner and the base material, complete freedom from cracks, and the same degree of soundness in the weld as required by the bend tests of process qualification under Section IX of the Code.

(17) All welded joints in the lining shall be given a tightness test by introducing air or other gas under pressure of 80 per cent of the design pressure of the vessel but not less than 80 psi between the wall and the liner and applying soap water solution to the exposed weld face, or by examination by magnetic powder, fluorescent penetrating oil, or any other suitable method approved by the authorized inspector. No leaks shall be permitted. When the air test is not used the effectiveness of the bond of the lining to the wall shall be demonstrated by any method acceptable to the inspector.

(18) The thickness of the lining shall not be included in the calculation of the required wall thickness of any vessel having a lining that is not completely and continuously bonded to the backing wall as required in (8) above.

(19) The service temperature and other limitations of (10) for clad material shall apply to linings of like composition.

A.S.M.E. NEWS

And Notes on Other Engineering Societies

Program of A.S.M.E. 1947 Semi-Annual Meeting at Stevens Hotel, Chicago, Ill., June 15-19, 1947

Sunday Tour and Social Evening Planned for Early Arrivals

IN ITS plans for the A.S.M.E. 1947 Semi-Annual Meeting to be held at the Stevens Hotel, Chicago, Ill., June 15 to 19, 1947, the A.S.M.E. Chicago Section has achieved a fine expression of the old A.S.M.E. tradition inspired by the enthusiasm of Alexander Lyman Holley when he convinced the founders in 1881 that fun and good fellowship are as much the life of the profession as is the serious work of engineering.

Pressed by the arbitrary requirement imposed on the Society by the headquarters hotel that at least 550 members take possession of rooms reserved for them by Sunday, June 15, Chicago Section members put their heads together and came forth with a great idea. They planned a program for Sunday afternoon which in itself is an inducement to visit their city and to participate in the technical sessions of the meeting.

Sunday Reception

The idea is this: On Sunday, when members arrive in Chicago, the local Section will have waiting at the hotel hosts of reception committees and scores of private cars. Visiting members and guests will be introduced to A.S.M.E. Chicagoans and taken on a 29-mile drive along the beautiful Michigan shore line and to any or all of the cultural or architectural show places of the city which may excite the interest of the visitors. The drive will terminate at the Michigan Shores Club in Wilmette, a suburb of Chicago, where a special dinner will be served and the evening given over to fun and entertainment. The entire facilities of the club have been engaged by the A.S.M.E. Chicago Section as a gesture of hospitality to the A.S.M.E. members, their wives, and guests, many of whom may be unfamiliar with the great city on the Lake. Here truly is an idea whose inspiration reaches back more than half a century to that first national meeting of the Society in Hartford, Conn., May, 1881, where the founders established the A.S.M.E. tradition of work and play.

The considerable expense involved in the idea is being met by the Chicago Section. Individual Chicagoans have volunteered use of their cars and are anticipating the pleasure of welcoming and conducting fellow members and their families and guests about the "windy city." Because the large attendance expected would impose too great a financial burden on the Section, a charge of $3 will be made for the dinner.

Technical Sessions

At the Stevens Hotel again on Monday morning, June 16, the 1947 Semi-Annual Meeting will get under way with official registration, technical sessions, luncheons, dinners, and inspection trips to local industrial plants and laboratories.

Some 32 technical sessions are planned at which 80 or more papers will be presented on a wide variety of mechanical-engineering problems. Eight sessions will be devoted to power, four to management, three to aviation, five each to fuels, metals engineering, and oil and gas power. One or two sessions will be given over to each of the following: heat transfer, industrial instruments and regulators, machine design, materials handling, process industries, production engineering, railroads, rubber and plastics, metal cutting, furnace performance factors, committee on elevators, and nuclear energy.

The power sessions will cover such subjects as external scale deposits on boiler tubes, economics of industrial and central-station power plants, review of heat-pump installations, furnace heat-transfer problems, and oil- and coal-burning gas-turbine power plants. On Tuesday evening the power session will hear

MICHIGAN SHORES CLUB, WILMETTE, ILL., WHERE THE A.S.M.E. CHICAGO SECTION WILL PLAY HOST TO THE SOCIETY AT A DINNER AND EVENING ENTERTAINMENT

Chicago Park District

CHICAGO, ILL., SHOWING THE STEVENS HOTEL IN THE LEFT FOREGROUND, SCENE OF THE A.S.M.E. 1947 SEMI-ANNUAL MEETING

papers on design and nuclear problems of the new field of atomic power engineering.

Management papers will cover studies of labor and management contributions to increased productivity, labor incentives and profit sharing, the relation of management to the union, and management's right to communicate with its workers.

Among the aviation papers will be a study on aircraft-cabin supercharging, precision-cast blades and high-temperature disk forgings for aircraft gas turbines, and liquid-propellant rocket motors.

The new A.S.M.E. Machine Design Division is sponsoring two sessions during which papers on semiuniversal toothed couplings, internal shoe clutches and brakes, stress determination by brittle coatings, and others will be discussed.

Although the program-making agencies of the Society have endeavored to institute the 90-day rule which requires that all papers be on hand at headquarters 90 days before a meeting, to be preprinted and distributed in advance for discussion, the unsettled conditions which still prevail in the Society prevented them from doing so. Consequently, few if any papers are ready at this printing for advance distribution, but they should be available in Chicago during the meeting.

Robert R. Wason to Address Banquet

For the banquet on Wednesday, June 18, which is the high light of an A.S.M.E. meeting, Robert R. Wason, president, Manning, Maxwell and Moore, Inc., New York, N. Y., and chairman of the Board of the National Association of Manufacturers, will address the meeting on a subject relating to the economics of engineering.

At this time, too, the Society will honor three of its senior members with A.S.M.E. Fifty-Year Membership Badges. They are: John T. Faig, fellow A.S.M.E., president of departments, Ohio Mechanics Institute, Cincinnati, Ohio; James Hervey Herron, past-president and fellow A.S.M.E., and president, James H. Herron Company, Cleveland, Ohio; and Charles H. Morse, member A.S.M.E., Chicago, Ill.

The Alfred Noble Prize will also be presented to Martin Goland, junior member A.S.M.E., chairman, engineering mechanics research, Midwest Research Institute, Kansas City, Mo., for his paper "The Flutter of a Uniform Cantilever Wing."

Diversified Inspection Program Planned

For those who wish to see the variety of manufacturing and processing industry in and around Chicago, the Plant Inspection Committee has scheduled six inspection tours for Monday, Tuesday, and Wednesday afternoons at 2:00 p.m. On Monday there will be a visit to the Corwith Works of the Crane Company, and another to the Onsrud Machine Works. The last will be sponsored by the A.S.M.E. Wood Industries Division in connection with its Spring Meeting in Madison, Wis., to be held a few days before the Semi-Annual Meeting.

Tuesday afternoon, visits are planned to the Calumet Generating Station of the Commonwealth Edison Company, and to the Armour Research Foundation of Illinois Institute of Technology. On Wednesday, June 18, trips to the Melrose Park Works of International Harvester Company, and to the Archer Avenue plant of Western Electric Company have been scheduled. Transportation to these various plants will be available at a nominal charge and reservations should be made in advance.

Valve and Fittings Manufacture

The Corwith Works of Crane Company is the world's largest plant devoted to the manufacture of valves, fittings, and fabricated piping. Facilities for casting valves and fittings in sizes from 1/8 in. to 72 in. of some 15 kinds of steel, 11 brass compositions, cast and malleable iron, and many special alloys are housed at this modern and highly efficient plant. Up to 250 tons of steel and more than 110 tons of brass are poured every day. The pipe-fabricating shop is equipped to produce special bends and welded assemblies for all piping requirements in sizes up to 30 in. O.D. The machine shops and assembling departments are equipped with the most modern tools and machines available. Special inspection and testing techniques are in use throughout the plant to insure quality control of the more than 30,000 items manufactured there.

Telephones at Hawthorne Works

In December, 1945, the Western Electric Company's gigantic Hawthorne Works in Chicago increased its manufacturing facilities by leasing the war-born plant of the Studebaker Corporation located at Archer and Cicero Avenues. From the manufacturing of aircraft engines, the plant was quickly converted to the manufacture of telephones. Soon, all previous telephone-production records were broken.

The plant now is producing telephones at the rate of 12,100 every day, having made nearly 2,500,000 in 1946 and setting its sights on a goal of more than 3,500,000 this year.

Housing more than 5600 employees, the windowless plant has a net floor space of 792,449 square feet. Mazes of overhead conveyers, the thump-thump of punch presses, and the glamour of plastic molding are only a few of the things impressing visitors to this single-floored example of straight-line production from raw material to finished product.

Industrial Research

The Armour Research Foundation of Illinois Institute of Technology is a nonprofit industrial-research laboratory which was founded in 1936. The Foundation occupies three buildings on the Institute campus on Chicago's South Side. The total number of employees are 445 of which 287 comprise the technical staff. Research is carried on in eight major fields: Ceramics and minerals, mechanics of solids, physics, metals, electrical engineering, chemistry and chemical engineering, mechanical engineering, and fluid mechanics and thermodynamics. In addition to research projects

ROBERT R. WASON, SPEAKER AT THE A.S.M.E. 1947 SEMI-ANNUAL BANQUET

for industrial sponsors, the Foundation engages in considerable fundamental research under an endowment system. Equipment and facilities are modern and versatile and include many specially developed instruments and machines. For example, the Foundation operates one of the few a-c-network calculators in the world. This machine is a device for solving complex mathematical problems by means of electrical analogies.

The Melrose Park Works

The Melrose Park Works, one of the nation's finest large manufacturing plants, is the newest of the three plants in the International Industrial Power Division network. Acquired in 1945, the plant, which was built just before Pearl Harbor for the production of bomber engines by the Buick Motor Car Company, has over 2,000,000 square feet of floor space and is laid out for streamlined production of industrial engines and tractors. Castings are received from International's Milwaukee Works and then are machined and assembled into complete engines at the Melrose Park Works. The new TD-24 Diesel Crawler, largest and most powerful crawler tractor ever built, is also a product of this plant.

Interesting Woman's Program

The A.S.M.E. Woman's Auxiliary of the Chicago Section plans a full program to entertain the women of other sections visiting at the Semi-Annual Meeting.

On Monday, June 16, a special lecture-demonstration has been arranged at the Adler Planetarium which is located on a promontory of Northerly Island in Lake Michigan, reached by a causeway. The popularity of this planetarium, where images of celestial bodies are projected on a stationary dome, is exemplified by the more than five million visitors who have examined the exhibits in the museum and listened to the lectures in the planetarium since its opening in 1930. In conjunction with the planetarium lecture, visits will be made to its neighboring institutions, The Chicago Museum of Natural History and the Shedd Aquarium, a notable concentration of public educational facilities dedicated to the study of "The heavens above, the earth beneath, and the waters under the earth."

In marked contrast to the educational features of the first day's program will be a bus tour of Chicago's most interesting places. It will cover part of the South Side and Lincoln Park as far north as the Edgewater Beach Hotel. The women will have lunch in the Marine Dining Room following which the tour will continue on back to the hotel.

On Wednesday there will be a conducted tour of Marshall Field's department store. This State Street store, which is a mecca for out-of-town visitors, is one of the show places of Chicago and a commerical institution to which any Chicagoan can point with justifiable pride. This "behind the scenes" tour through the many unique and interesting rooms and shops will be a high light of the women guests' visit for the Semi-Annual Meeting. A luncheon and fashion show in one of Field's famous Walnut Rooms will bring to a climax the program offered to the ladies by the A.S.M.E. Woman's Auxiliary.

The officers of the Woman's Auxiliary of the Chicago Section whose planning has made possible this eventful three-day program are: Chairman, Mrs. A. B. Openshaw; co-chairman, Mrs. J. R. Michel; treasurer, Mrs. R. J. Hinch; secretary, Mrs. J. C. Marshall; hospitality, Mrs. R. H. Bacon; and membership, Mrs. G. D. Olson.

Committee

Plans for the A.S.M.E. 1947 Semi-Annual Meeting are under the direction of the following: *General committee:* J. R. Michel, chairman; Robert H. Bacon, vice-chairman; H. W. Cross, secretary; F. A. Faville, assistant secretary. *Technical Sessions:* O. F. Campbell, chairman; Wm. H. Oldacre, vice-chairman; H. S. Nachman, J. D. Pierce, D. G. Reid, C. H. Simmons, H. E. Deady, and W. E. East. *Inspection Trips:* John P. Magos, chairman; R. D. Brizzolara, vice-chairman; Wm. A. Dundas, Edw. H. Taylor, J. F. Sullivan, and J. W. Kendrick. *Registration:* Vernon G. Leach, chairman; Jay C. Marshall, I. L. Wade, R. B. Gutekunst, and Ralph Hinch. *Reception:* W. T. McCullough, Jr., chairman; L. M. Johnson, vice-chairman; P. F. W. Waller, L. A. Ferguson, George D. Olson, Chas. S. Becker, A. L. Mitchell, and C. O. Hoban. *Entertainment:* A. B. Openshaw, chairman; Ralph Sargent, vice-chairman; Wm. A. Dundas, R. K. Behr, C. J. Clark, and S. B. Smith. *Student Group:* B. H. Jennings, chairman. *Hotel:* S. E. Winston, chairman; R. V. Dondanville, G. C. Laughlin, C. W. Parsons, and W. H. Pletta. *Print and Signs:* F. H. Lane, chairman; W. C. Kramer, D. G. Reid, and D. I. Payne. *Publicity:* C. C. Austin, chairman; R. E. Turner, A. H. Jens, J. D. Pierce, and J. B. Burkhart. *Finance:* P. F. W. Waller, chairman.

Registration Fee for Non-Members at the 1947 Semi-Annual Meeting

There will be a registration fee of $2 for nonmembers attending the 1947 Semi-Annual Meeting. For nonmembers wishing to attend just one session (except evening sessions or meal meetings) the fee will be $1. This is in accordance with the ruling of the Meetings Committee.

Members wishing to bring nonmember guests (male) may avoid this fee by writing to the Secretary of the Society before June 2, 1947, asking for a guest-attendance card for the Semi-Annual Meeting. The card, upon presentation by a guest, will be accepted in lieu of the registration fee. Guests are limited to *two per member*.

A.S.M.E. National Nominations

THE 1947 Nominating Committee invites Members to appear at its open meeting June 16, 1947, at the Stevens Hotel, Chicago, Ill.. Members may present their views concerning candidates for the offices of President, Regional Vice-President, or Director at Large, any time between the hours of 1 p.m. and 5 p.m. on Monday, June 16, 1947.

Tentative Program

A tentative program follows:

SUNDAY, JUNE 15

3:00 p.m.

Registration

Automobile trip around city terminating at Michigan Shores Club, Wilmette, for supper and informal evening

Technicolor motion picture of Chicago

MONDAY, JUNE 16

8:00 a.m.

Registration

9:30 a.m.

Heat Transfer (I)

Heat Transfer by Free Convection From Heated Vertical Surfaces to Liquids, by Y. S. Touloukian, assistant professor, mechanical engineering; G. A. Hawkins, Westinghouse research professor of heat transfer; both of Purdue University, Lafayette, Ind.; and M. Jakob, research professor of mechanical engineering, Illinois Institute of Technology, Armour Research Foundation, Chicago, Ill.

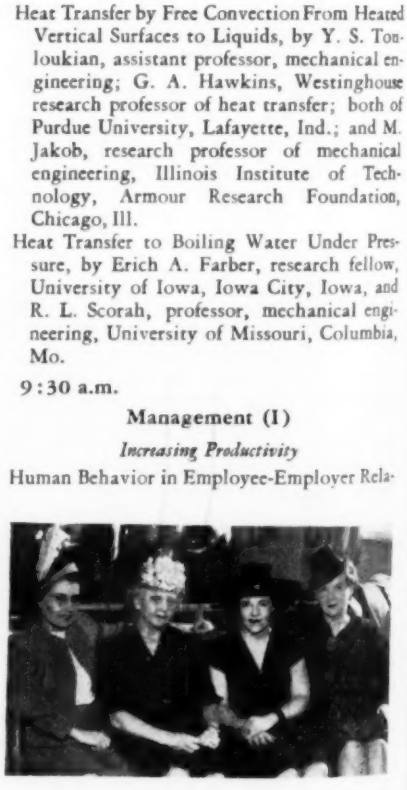
Heat Transfer to Boiling Water Under Pressure, by Erich A. Farber, research fellow, University of Iowa, Iowa City, Iowa, and R. L. Scorah, professor, mechanical engineering, University of Missouri, Columbia, Mo.

9:30 a.m.

Management (I)

Increasing Productivity

Human Behavior in Employee-Employer Rela-



OFFICERS OF THE A.S.M.E. WOMAN'S AUXILIARY OF THE A.S.M.E. CHICAGO SECTION

(*Left to right:* Mrs. R. J. Hinch, Mrs. R. H. Bacon, Mrs. A. B. Openshaw, chairman, and Mrs. J. R. Michel, vice-chairman.)

International Harvester

INSPECTION OF CYLINDER HEADS

tions, by J. A. Patton, president, J. A. Patton, Management Engineers, Inc., Chicago, Ill.

Incentives Reconsidered, by G. A. Holmes, manager of information, Western Electric Company, Inc., Hawthorne, Ill.

9:30 a.m.

Power (I)

The Economies of an Industrial Power Plant, by B. A. Lininger, power consultant, E. I. du Pont de Nemours and Company, Inc., Wilmington, Del.

Economies in Power Plant Design, by E. H. Krieg, consulting mechanical engineer, American Gas and Electric Service Corporation, New York, N. Y.

Quick Starting of High-Pressure Steam-Turbine Units, by J. C. Falkner, manager, electric production department; R. S. Williams, superintendent; and R. H. Hare, assistant engineer, Waterside Station, Consolidated Edison Company of New York, Inc., New York, N. Y.

9:30 a.m.

Metal Cutting and Cutting Fluids—Production Engineering

Torsional Stress Analysis of Twist Drill Sections by Membrane Analogy, by E. P. T. Neubauer, engineer, blower and compressor department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis., and O. W. Boston, chairman, department of metal processing, college of engineering, University of Michigan, Ann Arbor, Mich.

Tool-Chip Interface Temperatures, by K. J. Trigger, department of mechanical engineering, University of Illinois, Urbana, Ill.

Frozen Motion or Chip Contours as a Clue to the Mechanisms of Metal Cutting, by William H. Oldacre, president and general manager, and H. A. Erickson, chief engineer, D. A. Stuart Oil Company, Ltd., Chicago-Ill.

12:15 p.m.

President's Luncheon

Presiding: J. R. Michel, Commonwealth Edison Company, Chicago, Ill.

Welcome: Martin H. Kennelly, mayor of Chicago

Speaker: Eugene W. O'Brien, president A.S.M.E., vice-president and director, W. R. C. Smith Publishing Company, Atlanta, Ga.

Subject: Broader Vistas.

Ladies invited.

2:00 p.m.

Inspection Trips

(1) Crane Company, Corwith Works
(2) Onsrud Machine Works
Uniform charge: $1.75 each trip.

2:30 p.m.

Aviation (I)—Engineering Institute of Canada (I)

Frozen Foods for Airlines, by H. H. Darby, editor in chief, *Better Food*, Whitney Publications, Inc., New York, N. Y.

Aircraft Cabin Supercharging and Air Conditioning by Engine Bleed-Off, by R. B. Keusch, mechanical engineer power plant laboratory, and project engineer, on aircraft cabin conditioning, Air Materiél Command, Wright Field, Dayton, Ohio.

Passenger Service Requirements for North Atlantic Operations, by John Schwab, engineering department, Trans-Canada Air Lines, Winnipeg, Can.

2:30 p.m.

Heat Transfer (II)

Temperature Distribution in Some Simple Bodies Developing or Absorbing Heat as a Linear Function of Temperature, by M. Jakob, research professor of mechanical engineering, Illinois Institute of Technology, Armour Research Foundation, Chicago, Ill.

A Review of Available Data on the Dynamic Viscosity of Water and Superheated Steam, by G. A. Hawkins, Westinghouse research professor of heat transfer; W. L. Sibbitt, assistant professor; and H. L. Solberg, head, school of mechanical engineering, Purdue University, West Lafayette, Ind.

2:30 p.m.

Management (II)

Incentives to Production

The Junior Executive's Place in Production, by J. T. Brown, vice-president, Chain Belt Company, Chicago, Ill.

Profit Sharing as an Incentive, by Frank W. Willey, owner, Willey-Wray Electric Company, Cincinnati, Ohio

2:30 p.m.

Fuels (I)—Power (II)

Test Data on Gas-Side Sulphate-Type Deposits on Tubes Beyond the Boiler Furnace, by John F. Barkley, chief, fuels utilization division; L. R. Burdick, supervising engineer; and A. A. Berk, supervising chemist, Bureau of Mines, Washington, D. C.

The Possible Influence of Phosphorus on the External Fouling of Boiler Tubes, by Jean Valley, engineer, Brussels, Belgium (by title).

6:30 p.m.

General Dinner

Toastmaster: Alex D. Bailey, vice-president, Commonwealth Edison Company, Chicago, Ill.

Speaker: Charles E. Wilson, president, General Motors Corporation, Detroit, Mich.

Subject: (to be announced)

Entertainment and dancing

Ladies invited.

TUESDAY, JUNE 17

9:30 a.m.

Process Industries (I)

Industrial Waste Disposal—General Aspects and Trends in the Midwest, by George E. Barnes, professor of hydraulic and sanitary engineering, head, department of civil engineering and engineering mechanics, Case Institute of Technology, Cleveland, Ohio

Elimination of Waste Products of High Moisture Content in a Gas-Turbine System, by J. H. Potter, assistant professor, mechanical engineering, Johns Hopkins University, Baltimore, Md.

9:30 a.m.

Metals Engineering (I)

Recent Developments Concerning Properties of Cast Steels, by C. W. Briggs, technical and research director, Steel Founders' Society of America, Cleveland, Ohio

Engineering Uses for Steel Castings, by J. A. Rassenfoss, research metallurgist, research laboratory, American Steel Foundries, East Chicago, Ind.

Cast Bolts for Pipe Joints, by C. K. Donoho, chief metallurgist, American Cast Iron Pipe Company, Birmingham, Ala.

9:30 a.m.

Power (III)

A Review of Some Heat-Pump Installations, by E. B. Penrod, head, department of mechanical engineering, University of Kentucky, Lexington, Ky.

9:30 a.m.

Management (III)

Putting Management's House in Order, by Paul Polvsen, vice-president, Galvin Manufacturing Company, Chicago, Ill.

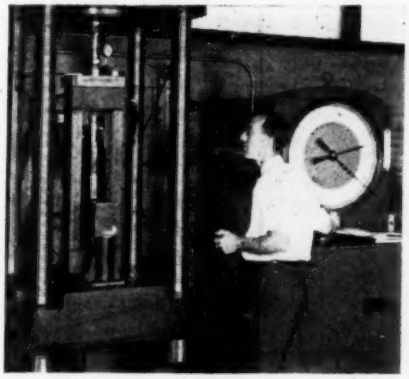
Dealing With the Union, by A. P. Nagel, employer's adviser, Employer's Association, Chicago, Ill.

12:15 p.m.

General Luncheon

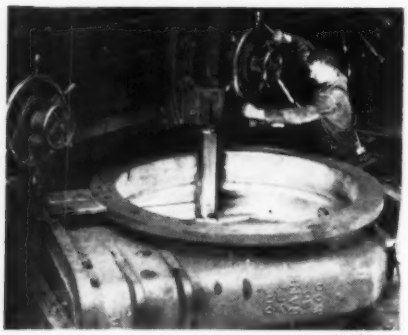
Presiding: F. A. Faville, president, Faville-LeVally Corporation, Chicago, Ill.

Speaker: L. J. Fletcher, director of training and community relations, Caterpillar Tractor Company, Peoria, Ill.



Armour

IN THE POULTER HIGH-PRESSURE LABORATORY AT THE ARMOUR RESEARCH INSTITUTE



Crane

MACHINING BODY SEAT RINGS IN A 66-IN. GATE VALVE AT THE CORWITH WORKS, CRANE COMPANY

Subject: The Influence of Sections in Public Activity

2:00 p.m.

Inspection Trips

(1) Commonwealth Edison Company, Calumet Generating Station
(2) Armour Research Foundation, Illinois Institution of Technology

2:00 p.m.

Furnace Performance Factors—Fuels (II)—Power (IV)—Heat Transfer (III)

An Investigation of the Variation in Heat Absorption in a Pulverized Coal-Fired Water-Cooled Steam-Boiler Furnace

PART (I)—Variations in Heat Absorption as Shown by Measurement of the Surface Temperature of the Exposed Side of Furnace Tubes, by Lyle B. Schueler, assistant mechanical engineer, American Gas and Electric Service Corporation, New York, N. Y.

PART (II)—Furnace Heat Absorption Efficiency as Shown by the Temperature Composition and Flow of the Gases Leaving the Furnace, by William T. Reid, assistant supervisor, fuels division, Battelle Memorial Institute, Columbus, Ohio; Paul Cohen, fuel engineer, and Richard C. Corey, supervising engineer, combustion research section, Bureau of Mines, Pittsburgh, Pa.

PART (III)—Variations in Heat Absorption as Shown by Density and Velocity Measurements of the Fluid Within a Tube, by Albert R. Mumford, development engineer, and Cyril G. R. Humphreys, engineer, research and development department, Combustion Engineering Company, Inc., New York, N. Y.

PART (IV)—Comparison and Correlation of the Results of Furnace Heat-Absorption Investigations, by Albert R. Mumford, development engineer, research and development department, Combustion Engineering Company, Inc., New York, N. Y., and Graham W. Bice, engineer, mechanical-engineering department, American Gas and Electric Service Corporation, New York, N. Y.

2:00 p.m.

Railroad

Forum on Diesel Locomotive Design for Reduced Maintenance:

Speakers: A. H. Candee, transportation engineer, Westinghouse Electric Corporation, East Pittsburgh, Pa.; J. W. Teker, General Electric Company, Erie, Pa.; M. D. Henshaw, General Electric Company, Erie, Pa.; John Seagran, American Locomotive Company, Schenectady, N. Y.; S. B. Paul, production engineer, American Locomotive Company, Schenectady, N. Y.; and D. R. Staples, The Baldwin Locomotive Works, Philadelphia, Pa.

2:30 p.m.

Metals Engineering (II)

Centrifugal Casting of Stainless and Carbon Steel Tubes, by J. W. Moore, president's staff, and J. W. MacKay, sales engineer, American Cast Iron Pipe Company, Birmingham, Ala.

The Manufacture of Tubes in Stainless Steel, Special Steel, Nickel, Monel, and Inconel by the Extrusion Method, by H. Lorant, vice-president and chief engineer, Hydropress, Inc., New York, N. Y.

Pressure-Welding Propeller Barrels, by G. W. Motherwell, works manager, A. L. Rustay, chief metallurgist, S. M. Jablonski, metallurgist, The Wyman-Gordon Company, Worcester, Mass.; and C. J. Burch, supervisor, process service, The Linde Air Products Company, Pittsburgh, Pa.

Industrial Instruments and Regulators —Research Committee on Elevators

On the Centrifugal Governor in Elevator Service, by F. Hymans, consulting engineer, Otis Elevator Company, New York, N. Y.

8:15 p.m.

Education

The Co-Operative Education Plan

Educational Viewpoint, by O. W. Eshbach, dean, Northwestern University, Evanston, Ill.

Co-Operative Training Program Approached From the Manufacturing Side, by E. H. Bankard, assistant foundry superintendent, Buick Motor Division, General Motors Corporation, Flint, Mich.

Power (V)—Nuclear Energy

Atomic Power Engineering—Some Design Problems, by Bruce R. Prentice, General Electric Company, Schenectady, N. Y.

Atomic Power Engineering—Some Nuclear Problems, by A. O. Nier, professor of physics, University of Minnesota, Minneapolis, Minn., and consultant, Kellex Corporation, New York, N. Y.

Chicago Park District

OAK STREET BEACH AND THE LAKE SHORE DRIVE, CHICAGO, ILL.

Crane

TAPING A HEAT IN THE VALVE FOUNDRY, CORWITH WORKS, CRANE COMPANY

8:15 p.m.

Materials Handling (I)

Mechanized Handling of Materials From Trees to Tribune, by Otto Wolf, chief engineer, *Chicago Tribune*, Chicago, Ill.

The Place of Materials Handling in Postwar Production, by Ezra W. Clark, Battle Creek, Mich.

8:15 p.m.

Management (IV)

Today's Pattern of Industrial Relations, by Raleigh Stone, professor, School of Business, University of Chicago, Chicago, Ill.

WEDNESDAY, JUNE 18

8:00 a.m.

Registration

9:30 a.m.

Process Industries (II)

Practice and Operating Techniques of Vertical Pressure Leaf Filters, by E. A. Ulrich, technical director, Niagara Filter Corporation, Buffalo, N. Y.

Distilling Plant Economy, by A. M. Impagliazzo, engineer, Griscom-Russell Company, New York, N. Y.

9:30 a.m.

Materials Handling (II)

The Solvent Method for Extraction of Vegetable Oils, by Guy V. Woody, manager, basic industries division, Allis-Chalmers Manufacturing Company, West Allis, Wis.

Materials Handling and Processing in the Modern Foundry (to be announced).

9:30 a.m.

Fuels (III)—Power (VI)—Oil and Gas Power (I)

Design Features of a 4800-Hp Mobile Gas Turbine Power Plant, by Alan Howard, turbine-engineering division, General Electric Company, Schenectady, N. Y.

Coal-Burning Gas Turbine Plant, by J. I. Yellott, director of research, and C. F. Kottcamp, assistant to the director, Locomotive Development Committee, Baltimore, Md.

GENERAL COMMITTEE OF THE A.S.M.E. CHICAGO SECTION

(*Seated, left to right:* A. B. Openshaw, C. C. Austin, T. S. McEwan, J. R. Michel, Ernest Hartford, Robert H. Bacon, B. H. Jennings. *Standing, left to right:* F. H. Lane, H. W. Cross, J. D. Pierce, Ralph Sargent, S. E. Winston, W. T. McCullough, R. D. Brizzolara, Vernon G. Leach, O. F. Campbell, F. A. Faville, W. H. Oldacre, P. F. W. Waller.)

12:15 p.m.

Fuels General Luncheon

Presiding: Julian E. Tobey, managing director, Fairmont Coal Bureau, New York, N. Y.

Speaker: Harold J. Rose, vice-president, director of research, Bituminous Coal Research, Inc., Pittsburgh, Pa.

Subject: Trends in Solid Fuel Research

2:00 p.m.

Inspection Trips

(1) International Harvester Company, Melrose Park Works.

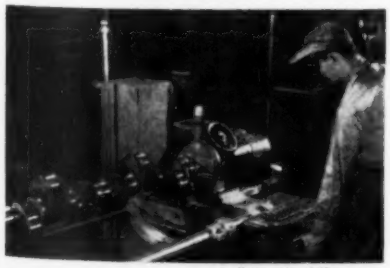
(2) Western Electric Company, Archer Avenue Plant

2:30 p.m.

Fuels (IV)

Meter for Flowing Mixtures of Air and Pulverized Coal, by H. M. Carlson, research engineer, Phillip M. Fazier, and R. B. Engdahl, assistant supervisor, Battelle Memorial Institute, Columbus, Ohio

Fluid Devolatilization of Coal for Power-Plant Practice, by A. D. Singh, president Singh and Company, Chicago, Ill., and Leslie J. Kane, formerly associate chemical engineer, Institute of Gas Technology, Chicago, Ill.



International Harvester

CHECKING ENGINE CRANKSHAFT FOR DYNAMIC BALANCE AT THE MELROSE PARK WORKS, INTERNATIONAL HARVESTER COMPANY

2:30 p.m.

Machine Design (I)

Semiuniversal Toothed Couplings, by Ernest Wildhaber, mechanical engineer, Gleason Works, Rochester, N. Y.

Internal Shoe Clutches and Brakes, by O. Von Mehren, project engineer, Thew Shovel Company, Lorain, Ohio

2:30 p.m.

Aviation (II)—Oil and Gas Power (II)—American Rocket Society

Liquid-Propellant Rocket Motors, by M. J. Zucrow, professor, mechanical engineering, Purdue University, Lafayette, Ind.

2:30 p.m.

Materials Handling (III)—Engineering Institute of Canada (II)

Coal Handling With Earth-Moving Equipment, by R. F. Legget, associate professor, civil engineering, department of civil engineering, University of Toronto, Toronto, Ont., Can., and R. L. Hearn, chief engineer, design and construction, Hydro-Electric Power Commission of Ontario, Toronto, Ont., Can.

Coal and Ashes Handling at Power Plants, by G. A. Gaffert, partner, Sargent & Lundy, Chicago, Ill.

6:30 p.m.

Banquet

Toastmaster: James D. Cunningham, president, Republic Flow Meters Company, Chicago, Ill.

Speaker: Robert R. Wason, president, Manning, Maxwell & Moore, Inc., and chairman of the Board, The National Association of Manufacturers, New York, N. Y.

Subject: To be announced

THURSDAY, JUNE 19

9:30 a.m.

Machine Design (II)

Stress Determination by Brittle Coating, by Greer Ellis, consulting engineer, Magnaflux Corporation, New York, N. Y.

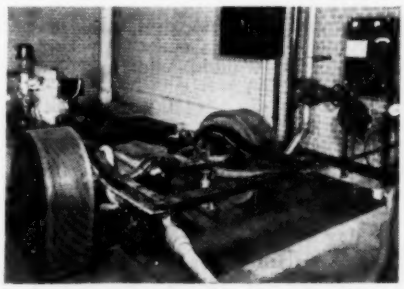
Applications for Stress Relief Hardening of Beryllium Copper, by R. W. Carson, president, Instrument Specialties Company, Little Falls, N. J.

Critical Speeds for Small Overhung Abrasive Wheels, by Kenneth Whitcomb, senior stress analyst, The Glenn L. Martin Company, Baltimore, Md.

9:30 a.m.

Fuels (V)—Power (VII)—Oil and Gas Power (III)

Developing and Testing of a Gas-Turbine Combuster, by A. E. Hershey, research engineer, research laboratory, Westinghouse Electric Corporation, East Pittsburgh, Pa.



Armour

ENGINE RESEARCH LABORATORY AT THE ARMOUR RESEARCH INSTITUTE

The Modern Gas Turbine in the Industrial Power Plant, by J. R. Haskins, Jr., betterment engineer, Union Electric Company of Missouri, St. Louis, Mo.

2:30 p.m.

Power (VIII)

An Investigation of Boiler Drum Steel After Forty Years' Service, by H. S. Blumberg, chief metallurgist, M. W. Kellogg Company, Jersey City, N. J., and G. V. Smith, research metallurgist, United States Steel Corporation, Kearny, N. J.

Action of Inhibited Hydrochloric Acid on Boiler Tubes, by Joseph L. Wasco and F. N. Alquist, research chemists, Dow Chemical Company, Midland, Mich.

2:30 p.m.

Rubber and Plastics

Motor Mount Testing Machine, by Lloyd E. Muller, Buick Division, General Motors Corporation, Flint, Mich.

Factors Affecting Performance of Aircraft Hydraulic Packings, by L. E. Cheyney, assistant supervisor, chemical research, and T. J. McCusition, research engineer, Battelle Memorial Institute, Columbus, Ohio

Some Properties and Mechanical Applications of Compar, by J. J. Hitov, molding engineer, Resistoflex Corporation, Belleville, N. J.

2:30 p.m.

Aviation (III)—Metals Engineering (III)

Precision-Cast Blades for Aviation Gas Turbines, by P. G. DeHuff, section engineer, metallurgical engineering, aviation gas-turbine division, Westinghouse Electric Corporation, Philadelphia, Pa.

High-Temperature Disk-Forging Developments for Aircraft Gas Turbines, by L. B. Fonda, metallurgical engineer, General Electric Company, Lynn, Mass.

The Fatigue Testing of Gas-Turbine Alloys by Means of the 120-Cycle Electromagnetic Fatigue Machine, by P. R. Toolin, research engineer, research laboratory, Westinghouse Electric Corporation, East Pittsburgh, Pa.

Meetings of Other Societies

May 21–22

American Iron and Steel Institute, 55th General Meeting, Hotel Waldorf-Astoria, New York, N. Y.

May 23–24

The Society of Naval Architects and Marine Engineers, Spring Meeting, Hotel Statler, Washington, D. C.

May 26–27

Association of Iron and Steel Engineers, Spring Conference, Benjamin Franklin Hotel, Philadelphia, Pa.

Tentative Program of A.S.M.E. 1947 Aviation Meeting, Los Angeles, Calif., May 26 to 29, 1947

THE A.S.M.E. 1947 Aviation Meeting will be held at the University of California, Los Angeles, Calif., May 26 to 29, 1947. Unique among A.S.M.E. affairs, this event attracts annually 10 to 15 hundred engineers to a program of closely knit technical sessions scheduled almost entirely in the evening hours without the usual interludes for social recreation.

The increasing popularity of the meeting, is a tribute to the enthusiasm and administrative ability of John E. Younger, formerly secretary of the A.S.M.E. Aviation Division, who has been called to Brazil recently to serve that country as professor of aircraft structures at its Aeronautical Institute of Technology. Dr. Younger was able, in spite of his important duties at the University of Maryland, to surmount the tremendous detail and labor involved in a national meeting of this magnitude. He carried a burden of correspondence and made several visits to the West Coast annually. Each year the result was a technical meeting in which the Society could take just pride.

This year Dr. Younger's responsibilities as "major-domo" have fallen to the A.S.M.E. Southern California Section currently under the leadership of Homer C. Reed, chairman, and A. R. Wiegel, secretary-treasurer. With the co-operation of the directors of the local professional divisions, they have organized a program that should excite more than a note of commendation from Dr. Younger in Brazil.

Sponsored by the A.S.M.E. Aviation Division and held so far from New York, the organizational details for the meeting necessarily had to fall on members better situated than the headquarters staff. Through the years the Division has had the enthusiastic support of the members in the Los Angeles area.

Technical Sessions

The program for the 1947 Aviation Meeting consists of 27 sessions and some 40 papers on aviation applied mechanics, metals, heat transfer, management, instruments and regulators, rubber and plastics, guided missiles, fuels and lubricants, and production and tooling.

Committees

Credit for the work and planning of the meeting go to the following: *General Arrangements Committee:* T. E. Colvin, general chairman; L. M. K. Boelter, program chairman; Paul F. Arnerich, assistant program chairman; W. E. Mason, arrangements chairman; John G. Braun, publicity chairman; E. K. Springer, reception chairman.

A.S.M.E. Southern California Section Officers: Homer C. Reed, chairman; A. R. Weigel, secretary-treasurer; V. A. Peterson, Don Jones, V. L. Peickii, E. W. Young, and J. B. Johnson, executive committee members.

Directors of Professional Divisions: Given Brewer, E. O. Bergman, W. P. Glancy, Paul F. Arnerich, R. T. Knapp, R. B. Esselman, S. G. Eskin, and John G. Braun.

National Aviation Committee: J. E. Younger, J. E. Colvin, J. I. Brewster, Bruce Del Mar, Walter H. Del Mar, John Delmonte, J. C. Dillon, Erich Marx, W. E. Mason, C. M. Sandland, Wm. Schroeder, E. K. Springer.

A.S.M.E. Aviation Division: R. P. Kroon, chairman; E. Britton, secretary; F. K. Teichmann, T. E. Colvin, E. S. Thompson, and Herman Hollerith, Jr.

Tentative Program

A tentative program follows:

MONDAY, MAY 26

7:30 p.m.

General Session

Increased Safety in Aviation Through Radar, by Lee A. DuBridge, president, California Institute of Technology, Pasadena, Calif.

8:45 p.m.

Applied Mechanics and Metals

Design Involving Large Wrought-Aluminum Sections, by E. H. Spaulding, structures engineer, Lockheed Aircraft Corporation, Burbank, Calif.

Fabrication of Large Aluminum Sections, by Kirby Thornton, aircraft development engineer, Alcoa, New Kensington, Pa.

8:45 p.m.

Heat Transfer

Measurements of Aerodynamic Heating at High Mach Numbers, by H. A. Johnson, department of engineering, University of California, Berkeley, Calif.

8:45 p.m.

Instruments and Regulators

Instrumentation for Flight Testing XB-45 Bomber, by D. K. Warner, supervisor of flight-test instrumentation, North American Aviation, Inc., Inglewood, Calif.

8:45 p.m.

Management

Planning for Better Managerial Control in the Aviation Industry, by Merrill R. Lott, management engineer, Los Angeles, Calif.

8:45 p.m.

Rubber and Plastics

Plastics in Airframe Interiors, by R. J. Considine, plastics engineer, Douglas Aircraft Company, Inc., Santa Monica, Calif.

TUESDAY, MAY 27

4:00 p.m.

Applied Mechanics and Metals

Rubber Hydropress Forming of Magnesium and Aluminum Alloys at Elevated Tempera-

tures, by D. M. Cunningham, lecturer, department of engineering, University of California, Berkeley, Calif.

Press Forging Thin Sections: Effect of Friction, Area, and Thickness on Pressures Required, by William Schroeder and D. A. Webster, research engineers, Lockheed Aircraft Corporation, Burbank, Calif.

4:00 p.m.

Heat Transfer

Ram-Operated Cooling Systems for Supersonic Aircraft, by Jackson R. Stadler, engineer, National Advisory Committee for Aeronautics, Ames Aeronautical Laboratory, Moffet Field, Calif.

Heat Transfer in Aircraft Anti-Icing Constructions, by H. A. Johnson, department of engineering, University of California, Berkeley, Calif., and V. D. Sanders, engineer, General Electric Company, Schenectady, N. Y.

4:00 p.m.

Guided Missiles

The Flying Stovepipe and How it Works, by J. P. D'Arezzo, applied physics laboratory, Johns Hopkins University, Baltimore, Md.

Material Considerations in Ram-Jet Vehicles, by C. W. Besserer, applied-physics laboratory, Johns Hopkins University, Baltimore, Md.

7:30 p.m.

General Session

The Present Status of the Guided Missile, by H. J. Stewart, associate professor of aeronautics and meteorology and chief, theoretical analysis section, jet-propulsion laboratory, California Institute of Technology, Pasadena, Calif.

8:45 p.m.

Applied Mechanics and Metals

Stretch Forming of Aluminum Alloys at Elevated Temperatures, by I. G. Lotze, lecturer, department of engineering, University of California, Berkeley, Calif.

8:45 p.m.

Heat Transfer

An Analysis of Heat Transfer Over a Small Cylinder in Icing Conditions on Mount Washington, by L. M. K. Boelter, dean, college of engineering; Myron Tribus, research engineer and lecturer in engineering; and George Young, research engineer and lecturer in engineering, all of University of California, Los Angeles, Calif.

8:45 p.m.

General Session

Fatigue Testing of Pressure Cabin Structures, by R. H. Christensen, Douglas Aircraft Company, Inc., Santa Monica, Calif.

8:45 p.m.

Management

Airline Management's Problems, by Richard A. Dick, vice-president in charge of traffic and advertising, Western Air Lines, Inc., Beverly Hills, Calif.

8:45 p.m.

Fuels and Lubricants

Development of Lubrication Requirements for Aircraft, by Marion H. Stalker, process engineer, Lockheed Aircraft Corporation, Burbank, Calif.

Aviation Fuels, Present and Future, by A. Hundere and J. A. Bert, California Research Corporation, San Francisco, Calif.

WEDNESDAY, MAY 28

7:30 p.m.

General Session

Development of Aircraft for Supersonic Flight, by E. H. Heinemann, chief engineer, Douglas Aircraft Company, Inc., El Segundo, Calif.

8:45 p.m.

General Session

Static Testing of Large Transport Aircraft, by W. W. Bradley, engineering department, Douglas Aircraft Company, Inc., Santa Monica, Calif.

8:45 p.m.

Heat Transfer

Limitations and Mathematical Basis for Predicting Aircraft-Icing Characteristics from Scale-Model Studies, by L. M. K. Boelter, dean, college of engineering; Myron Tribus and George Young, research engineers and lecturers in engineering, department of engineering, all of University of California, Los Angeles, Calif.

8:45 p.m.

Fuels and Lubricants

An Analysis of Aviation Turbine Fuel Performance Factors Affecting the Design and Operation of Commercial Aircraft, by C. R. Johnson, Shell Oil Company, San Francisco, Calif.

8:45 p.m.

Rubber and Plastics

Thermosetting Laminates in Aircraft Construction, by G. R. Huisman, chief plastics engineer, North American Aviation, Inc., Inglewood, Calif.

8:45 p.m.

Production and Tooling

Tooling and Production of the Douglas "Cloudster" Prototype Five-Passenger Executive Airplane, by C. D. Hencharger, superintendent, design and tool engineer, Douglas Aircraft Company, Inc., Santa Monica, Calif.

THURSDAY, MAY 29

7:30 p.m.

Heat Transfer

Symposium on Aircraft Air-Conditioning: Speakers are: Craig Taylor, department of engineering, University of California, Los Angeles, Calif.; Homer Wood, air research, Los Angeles, Calif.; Ralph Hitchcock, Boeing Aircraft, Seattle, Wash.; Bernard Messenger, Lockheed Aircraft Company, Burbank, Calif.; Fred Boeke, North American Aviation, Inc., Inglewood, Calif.; W. W. Reaser, Douglas Aircraft Co., Inc., Santa Monica, Calif.; Jackson R. Stadler, National Advisory Committee for Aeronautics, Ames Aeronautical Laboratory, Moffet Field, Calif.

7:30 p.m.

Applied Mechanics and Metals

Stress Distribution in Notch Coupons, by R. C. Zaller, structures engineer, Consolidated Vultee Aircraft Corporation.

Effect of Eccentric Holes, by Leo Shapiro, supervisor, materials laboratory, Douglas Aircraft Company, Inc., Santa Monica, Calif.

7:30 p.m.

Steam Power

Steam Power in Aviation, by William Bessler, Bessler Corporation, Emeryville, Calif.

Steam-Jet-Driven Wind Tunnels, by Richard Folsom and Enos Kane, department of engineering, University of California, Berkeley, Calif.

7:30 p.m.

General Session

Recent Advances in Silencing Aircraft, by Ken R. Jackman, chief test engineer, Consolidated Vultee Aircraft Corporation, San Diego Division, San Diego, Calif.

Cargo Refrigeration, by L. R. Hackney, Lockheed Aircraft Corporation, Burbank, Calif.

7:30 p.m.

Production and Tooling

Mechanics of Building the North American "Wing," by Douglas G. Leland, superintendent, production engineering, Northrop Aviation Corporation, Hawthorne, Calif.

Simplified Fabrication of Plaster Patterns, by John S. Halterman, manager of manufacturing and preplanning, Lockheed Aircraft Corporation, Burbank, Calif.

7:30 p.m.

Guided Missiles

Servoamplifiers and the Stability of Guided Missiles, by Louis Pipes, research physicist, Hughes Aircraft Company, Culver City, Calif.

Elementary Supersonics, by William C. Randels, aeronautical engineer, North American Aviation, Inglewood, Calif.

Swedish Engineers to Hold Instruments Conference

THE Royal Swedish Academy of Engineering Sciences and the Association of Technical Physics are planning a conference on instruments and measurements to be held in Stockholm, Sweden, June 4 to 7, 1947.

The conference will cover the technique of measurements and related subjects, and will conduct symposiums on industrial spectroscopy, testing of materials, industrial control, and metrology. An exhibition of instruments and laboratory equipment is also planned.

An invitation to the conference has been extended to American engineers.

F.A.S. Protests Civilian Jobs for German Scientists

THE Federation of American Scientists, a federation of 17 local associations of scientists interested in the political problems of atomic energy, urged recently that civilian jobs be denied to German scientists brought here by the Army for military research and that they be returned to their homeland "as soon as possible."

A letter to President Truman from W. A. Higinbotham, executive secretary, F.A.S., suggested that any favors extended to these citizens of a former enemy would represent an "affront" to the peoples of our wartime Allies.

The War Department said last December that it had brought over almost 350 war technicians from Germany, and had plans to bring in as many as 1000 to assist on military projects. While the scientists came here in Army custody, they would, after a period of observation, earn consideration for immigration status. According to the Army this program is still in progress.

The F.A.S. was formed in January, 1946, by scientists active on atomic projects and research centers, as a political-action organization "to meet the increasingly apparent responsibility of scientists in promoting the welfare of mankind and the achievement of a stable world peace." It has a membership of 3000.

By means of interlocking memberships and personal contacts and conferences, the F.A.S. maintains close liaison between the Emergency Committee of Atomic Scientists and the Association of Scientists for Atomic Education.

The Emergency Committee consists of ten scientists, headed by Albert Einstein. Its only purpose is to raise funds for educational effort on atomic energy.

The purely educational A.S.A.E. was formed to remove the burden of a large educational program with its problems of financing from the program of the F.A.S. whose objectives lie primarily in the field of political action.

The Federation follows closely the work of the United Nations Atomic Energy Commission, United States Atomic Energy Commission, and groups in the State Department.

1947 American Year Book to Be Released Soon

THE thirty-second edition of *The American Year Book*, A Record of Events and Progress for 1946, is scheduled for publication this month. The book is prepared by The American Year Book Corporation, representing 46 learned societies, including the A.S.M.E., and covers the developments in 27 major fields of activities.

The chapter covering the developments in mechanical engineering during 1946 was written by J. J. Jaklitsch, Jr., junior member A.S.M.E., of the Society's editorial staff.

The book is published by Thomas Nelson and Sons, 385 Madison Avenue, New York, N. Y., and sells for $12 per copy.

13th Annual Conference on Applied Mechanics to Be Held June 23–25

Papers by Foreign Authors to Be Read

THE 13th Annual Conference on Applied Mechanics sponsored by the A.S.M.E. Applied Mechanics Division in co-operation with the A.S.M.E. Schenectady Section will be held in the Physics Building, Union College, Schenectady, N. Y., June 23 to 25, 1947. Business meetings of the Division and the social events will be held at the Hotel Van Curler, A.S.M.E. headquarters during the Conference.

The technical program will consist of five technical sessions during which 24 papers, some of them by English, Italian, and Chinese authors, will cover such phases of applied mechanics as strength of materials, theory of metals, and fluid mechanics.

Registration will commence on Monday morning in the Physics Building, Union College, and the first session is scheduled shortly after. To facilitate registration and to eliminate the inconvenience of waiting in line before the registration desk, it is planned to mail registration cards to members of the Division so that the cards can be filled out leisurely in advance of the Conference. This procedure should mean speedy and efficient service and a prompt start of the technical program. Registration will be free to members and guests.

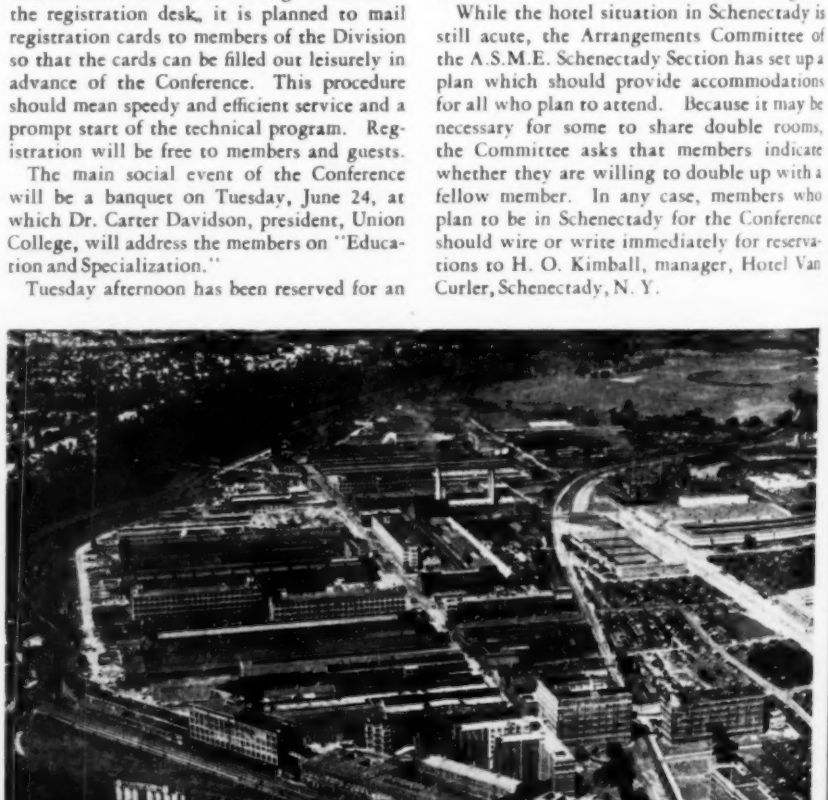
The main social event of the Conference will be a banquet on Tuesday, June 24, at which Dr. Carter Davidson, president, Union College, will address the members on "Education and Specialization."

Tuesday afternoon has been reserved for an inspection tour of the famous River Works, General Electric Company. Visitors will also see the G.E. Science show "House of Magic."

While the hotel situation in Schenectady is still acute, the Arrangements Committee of the A.S.M.E. Schenectady Section has set up a plan which should provide accommodations for all who plan to attend. Because it may be necessary for some to share double rooms, the Committee asks that members indicate whether they are willing to double up with a fellow member. In any case, members who plan to be in Schenectady for the Conference should wire or write immediately for reservations to H. O. Kimball, manager, Hotel Van Curler, Schenectady, N. Y.

Registration and Rooms

HOTEL reservations for the Conference on Applied Mechanics call for prompt action. Wire or write to H. O. Kimball, manager, Hotel Van Curler, Schenectady, N. Y., and make known your requirements. To save time and avoid inconvenience at the registration desk, fill out registration cards in advance. Registration is free to members and guests.



GENERAL ELECTRIC COMPANY WORKS IN SCHENECTADY, N. Y., TO BE VISITED BY MEMBERS ATTENDING THE A.S.M.E. CONFERENCE ON APPLIED MECHANICS, JUNE 23 TO 25

MEMBERS OF THE A.S.M.E. SCHENECTADY SECTION, HOST SECTION TO THE A.S.M.E. CONFERENCE ON APPLIED MECHANICS

(*Right*, Anthony J. Nerad, chairman, A.S.M.E. Schenectady Section. *Left*, Charles Concordia, chairman, Arrangements Committee and co-author of one of the papers to be presented at the Conference.)

Tentative Program

A tentative program follows:

MONDAY, JUNE 23

9:00 a.m.

Registration

10:00 a.m.

Session I

Generalized Vibration Analysis by Means of the Mechanical Transients Analyzer, by G. D. McCann and J. M. Kopper, both of California Institute of Technology, Pasadena, Calif.

The Mobility Method Applied to Mechanical Wave Filters With Inductive Coupling, by Alice Winzer, Brown University, Providence R. I.

An Introduction to an Analysis of Gas Vibrations in Engine Manifolds, by R. C. Binder and A. S. Hall, Jr., both of Purdue University, Lafayette, Ind.

Torsion and Shear Effects of Members Upon General Instability of Semi-Monocoque Structures, by Tsun Kuei Wang, National Northwest University, Sian, China. (by title)

Simplified Calculation of Double-Curved Shells, by O. Belluzzi, University of Bologna, Italy (by title).

2:00 p.m.

Session II

Inventions in Engineering Development, by D. W. McLenegan, General Electric Company, Schenectady, N. Y.

Stress Concentration Around an Ellipsoidal Cavity in an Infinite Body Under Arbitrary Plane Stress Perpendicular to the Axis Revolution of the Cavity, by M. A. Sadowsky and E. Sternberg, both of Illinois Institute of Technology, Chicago, Ill.

Camtograms for Beams in Compression, by V. Rojansky, Union College, and R. A. Beth, Western Reserve University.

The Swelling of an Orthotropic Circular Tube, by C. Gurney and A. Hammond, Farnsborough, Hants, England (by title).

8:00 p.m.

Executive Committee Business Meeting
Garden Room, Hotel Van Curler

TUESDAY, JUNE 24

9:00 a.m.

Session III

Combined-Stress Tests on 24S-T Aluminum-Alloy Tubes, by William R. Osgood, David Taylor Model Basin, Washington, D. C.

Correlation of Tension Creep Tests With Relaxation Tests, by E. P. Popov, University of California, Berkeley, Calif.

Derivation of Stress, Strain, Temperature Strain Rate Relation for Plastic Deformation, by J. H. Hollomon and J. D. Lubahr, General Electric Company, Schenectady, N. Y.

A New Feature Strength-Damping Criterion for the Design of Resonant Members, by Joseph Marin, The Pennsylvania State College, State College, Pa., and F. B. Stulen, Curtiss-Wright Corporation.

2:00 p.m. to 5:00 p.m.

Visit to River Works, General Electric Company and "House of Magic."

6:30 p.m.

Banquet
Hotel Van Curler

Speaker: Dr. Carter Davidson, president, Union College, Schenectady, N. Y., who will talk on "Education and Specialization."

WEDNESDAY, JUNE 25

9:30 a.m.

Session IV

DC Network Analyzer Determination of Fluid-Flow Patterns in a Centrifugal Impeller, by C. Concordia and G. K. Carter, General Electric Company, Schenectady, N. Y.

On the Aerodynamic Design of Axial-Flow Compressor and Turbines, by Andrew Vazsonyi, North American Aviation, Inc.

Elbows for Accelerated Flow, by G. F. Carrier, Brown University, Providence, R. I.

Calculation of Diffuser Efficiency for Two-Dimensional Flow, by R. C. Binder, Purdue University, Lafayette, Ind.

2:00 p.m.

Session V

The Calculated Performance of Dynamically Loaded Sleeve Bearings, by John T. Burwell, Massachusetts Institute of Technology, Cambridge, Mass.

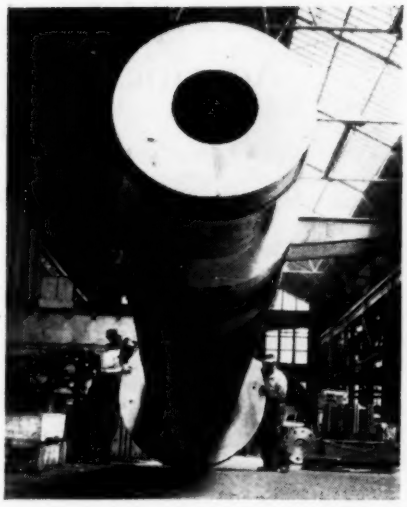
Polar Strain, by C. W. Harris, The B. F. Goodrich Company, Akron, Ohio.

Theoretical Considerations in Calculating Sliding Friction of Ball Bearings of the Pivot Type, by H. Poritsky, C. W. Hewlett, Jr., and R. E. Coleman, Jr., all of General Electric Company, Schenectady, N. Y.

The Shape and Tension of a Light Flexible Cable in a Uniform Current, by L. Landweber and M. H. Protter, both of Brown University, Providence, R. I.

The Theory of the Tuned and Damped Vibration Absorbers, by J. E. Moyal, DeHavilland Propellers, Ltd., Hatfield, Hertfordshire, England (by title).

A Concentrated Force Problem of Plane Strain and Plane Stress, by A. E. Green, The University of Durham, Durham, England (by title).



WATER-WHEEL GENERATOR SHAFT, PART OF THE BONNEVILLE DAM POWER PROJECT, MANUFACTURED AT SCHENECTADY

A.S.E.E.—A.S.M.E. Summer School Announced

THE Summer School for Mechanical Engineering Teachers, discontinued during the war, will be re-established this summer on the campus of Northwestern University, Evanston, Ill., June 14 to 18, 1947, under the sponsorship of the Committee of the Mechanical Engineering Division of the American Society for Engineering Education and The American Society of Mechanical Engineers.

Facilities for the school sufficient for an enrollment of 100 to 150 teachers have been provided by the Northwestern University, while specialists in mechanical engineering and the teachers of mechanical engineering have volunteered to take part in the five-day program which aims to help teachers by giving them new technical information on mechanical engineering and the latest developments in the art of teaching.

The Summer School was planned with the convenience of teachers in mind who might want to attend sessions planned for the A.S.M.E. Semi-Annual Meeting in Chicago, Ill., June 15 to 19, and the A.S.E.E. Summer Meeting in Minneapolis, Minn., June 18 to 21.

Information on registration, accommodations at the University, and fees may be obtained by writing to Prof. Burgess H. Jennings, Department of Mechanical Engineering, Technical Institute, Northwestern University, Evanston, Ill.

For information on the final program, inquiries should be addressed to Prof. Frank L. Schwartz, Mechanical Engineering Department, University of Michigan, Ann Arbor, Mich.

E.J.C. Participation in International Activities Encouraged by State Department

Engineers Advisory Commission to be Formed

NOT the least significant result of the E.J.C. reports on the disarmament of Germany and Japan has been the enhanced prestige of the engineering profession in government circles. Especially in the State Department, pressed as it is by the war of ideologies ranging in all fronts, the reports have inspired confidence in and a willingness to consult with the agencies for public service organized by the E.J.C.

At a recent meeting of the E.J.C. Committee on International Relations, two representatives of the State Department, Haldore Hanson and E. Theodore Arndt, were present to explain how engineers can aid in refuting totalitarian untruths and the part they will be called upon to play under two bills, the Bloom Bill and the Fullbright Bill, now pending in Congress.

Mr. Hanson told the Committee that totalitarian propaganda abroad is engaged in a five-point program of lies and distortions which portray the United States as imperialistic, undemocratic, militaristic, reactionary, and culturally backward. Facts which do not "jibe" with these stereotypes are rigorously repressed. Facts favorable to the United States are available only to a limited extent through libraries and cultural attachés, attached to embassies and through overseas broadcasting.

Another source of truth abroad, not yet fully developed, is the international exchange of students, and professors, and the visits of commercial men. Foreign visitors coming here compare the fact with the fiction, and on returning home, report their experiences. Americans abroad have the same salutary effect.

The Bloom Bill

Referring to the proposed International Interchange and Information Act of 1947 (Bloom Bill), Mr. Hanson explained the object of the act was to promote understanding between the United States and other countries of the world by interchange of persons and services and dissemination of facts about this country and its principles and objectives.

Mr. Hanson also called attention to the Fullbright Bill, under which some of the funds from the sale of surplus war stocks abroad will be used to finance American professors and students lecturing abroad, and under which engineers may be of public service.

The Bloom bill, which has won the approval of the E.J.C., requires that the State Department "shall invite outstanding leaders, both within and outside the Federal Government, in the various fields of engineering to the United States to review and advise on the Secretary's policies in rendering engineering services to another government." Under this provision, the State Department has requested the E.J.C. to set up an Engineers' Advisory Commission to the Secretary of State.

Advised that the E.J.C. had already taken action to organize such a commission, Mr. Hanson stated that not only the Assistant Secretary for Public Affairs, but the Office of the Under Secretary for Economic Affairs and probably the Department of Commerce would wish to consult with it.

Mr. Arndt reported to the Committee that the State Department had acted on its request to prepare a roster of foreign engineering students in the United States. The purpose of the roster is to enable the E.J.C. through its constituent societies to give foreign students in this country a better knowledge of American engineering practice and an understanding of the professional ideals of American engineers.

Following a discussion of the State Department's overseas program "Voice of America," and the desire of foreign engineers to exchange correspondence with American engineers, the Committee agreed that the new E.J.C. Engineers Advisory Commission should work with the State Department to develop material for engineering programs to be used in the "Voice of America" broadcasts.

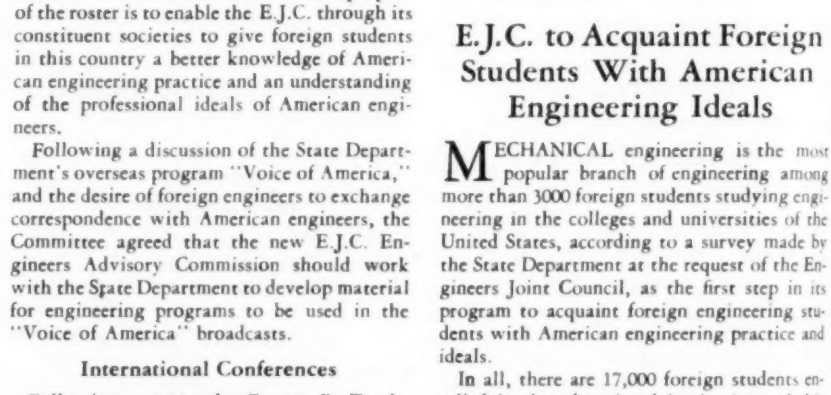
International Conferences

Following a report by Fenton B. Turck, member A.S.M.E., United States delegate to the World Engineering Conference, on the minutes of the W.E.C. Executive Board, it was agreed that the E.J.C. should proceed with the organization of the United States National Committee to the W.E.C. Also discussed was the suggestion that state and local engineering organizations councils as well as national engineering societies be invited to membership in the W.E.C. National Committee.

The next meeting of the W.E.C. Executive Board is tentatively set for September, 1947, in Zurich, Switzerland. Prompt action by American engineering organizations in setting up a National Committee will enable an American delegate to be present to discuss the invitation received from Egypt to hold the next World Engineering Congress in Cairo in 1948 or 1949, Mr. Turck said.

The Committee agreed to encourage participation of E.J.C. constituent societies and the American Standards Association in the Instruments and Measurements Conference, which is to be held June 4 to 7, 1947.

S. S. Steinberg reported that a proposal has been made for a Pan-American Engineering Congress to be held soon at Bogota, Columbia, and a second congress a year later in Buenos Aires, Argentina.



E.J.C. COMMITTEE ON INTERNATIONAL RELATIONS

(*Seated, left to right:* E. Theodore Arndt, R. M. Gates, Malcolm Pirnie, Howard Coonley, Haldore Hanson. *Standing, left to right:* C. E. Davies, Fenton B. Turck, S. S. Steinberg, S. P. Wimpfen, Ernest Pragst, Joseph Pope, George A. Stetson, Stewart E. Reimel, H. H. Henline, William N. Carey.)

E.J.C. to Acquaint Foreign Students With American Engineering Ideals

MECHANICAL engineering is the most popular branch of engineering among more than 3000 foreign students studying engineering in the colleges and universities of the United States, according to a survey made by the State Department at the request of the Engineers Joint Council, as the first step in its program to acquaint foreign engineering students with American engineering practice and ideals.

In all, there are 17,000 foreign students enrolled in the educational institutions of this country. Of the engineering students, there are 937 from nine Middle and Far East countries alone. They include 29 from Greece, 178 Turkey, 287 India, 47 Egypt, 37 Iran, 18 Iraq, 300 China, 38 Philippines, and 3 from Afghanistan.

Among the students are 955 studying mechanical engineering, 706 civil engineering, 286 chemical engineering, 274 mining and metallurgical engineering, and 263 electrical engineering.

The State Department report issued on March 21, 1947, was the first comprehensive compilation of all data available on foreign students enrolled in United States schools. The E.J.C. asked for information on foreign engineering students so that it could take a part in introducing these students to professional engineering societies. Through membership of its constituent societies, the E.J.C. hopes to give foreign students a better knowledge of American engineering and construction practice, and an understanding of the professional ideals of American engineering. By cultivating friendships now, the E.J.C. hopes to develop closer professional contacts with similar professional groups abroad.

A.S.M.E. Plans Action on Junior Problem

A JUNIOR Committee composed of three junior and two full members has been organized under the direction of the A.S.M.E. Board on Education and Professional Development to study the complex problems of the young man in the profession. Much larger than the question of unionization or licensing, the over-all problem of the junior can be considered generally as one of the individuals who has lost his individuality in a larger group of men of similar training, and one that probably would be with the Society, though in less troublesome form, even though there were no Wagner Act, and concern over professional or economic status.

The Committee has been charged with the following tasks: (1) Development of opportunities for the junior engineer in the A.S.M.E. and industry. (2) Interpretation of the survey reports flowing from the E.J.C. Committee on Economic Status of the Engineer and recommendation of proper Society action. (3) Maintenance of contact with the current E.J.C. activities, relating to the educational and professional development of the engineer.

The Committee is composed of the following: Philip Allen, junior member A.S.M.E., test laboratory, U. S. Naval Base, Philadelphia, Pa.; Charles H. Carman, Jr., junior member A.S.M.E., sales engineer, Elliott Company, New York, N. Y.; Donald E. Jahnake, junior member A.S.M.E., plant-layout engineer, Plymouth Division, Chrysler Corporation, Detroit, Mich.; George B. Thom, member A.S.M.E., director of training, Sun Shipbuilding and Drydock Company, Chester, Pa.; and H. C. Thuerk, member A.S.M.E., president, New Jersey Light and Power Company, Dover, N. J.

With regard to the junior problem, the A.S.M.E. Education Committee is planning two sessions at the 1947 Annual Meeting at Atlantic City, N. J. At one session eight junior members, one from each of the Regions, will speak on "What Do We Expect and What Are Our Responsibilities?" At the other session the subject will be "The Introduction of the Junior Engineer to His Society, to His Job, and to his Community."

A.S.M.E. 19th National Oil and Gas Power Conference to Feature Special Lectures, Exhibits, and Technical Program

ENGINEERS working with Diesel fuel oils will hail the initiative of the A.S.M.E. Oil and Gas Power Division in planning a one-day three-session lecture course on Diesel Fuel Oils as part of the program of the A.S.M.E. 19th Annual Oil and Gas Power Conference to be held at the Statler Hotel, Cleveland, Ohio, May 21 to 24, 1947.

With an ear to the needs of returning veterans and busy engineers who could benefit from a well-integrated and authoritative review of what has been happening during the past few years in the field of Diesel fuels, the Executive Committee appointed a Committee on Lectures. This committee was successful in securing three authorities, each to deliver two-hour lectures on the following topics: Production of Diesel fuel oils; physical and chemical characteristics of Diesel fuel oils; and combustion of Diesel fuel oils.

So that those who register for the lecture course will not miss any of the technical sessions and events planned for the Conference, the lecture program was scheduled on the day preceding the official opening of the regular program. To defray expenses, a fee of $12 to members and $15 to guests will be charged.

These lectures present an unusual opportunity for engineers in the Diesel field to obtain an up-to-the-minute understanding of the developments in Diesel fuel oils. These should be of special interest to the technical staffs of Diesel engine manufacturers, fleet, and other large operators of Diesel engines, educators, and government engineers. Each lecture will be followed by an informal discussion. The size of the audience will be restricted to assure maximum benefit and convenience to members and guests. Registrations will be honored as received. It is suggested that registrations be arranged promptly by writing to W. L. H. Doyle, Caterpillar Tractor Company, Peoria, Ill.

In accordance with the practice of the Oil and Gas Division, there will be an exhibit of Diesel engines and accessory equipment. With the co-operation of Diesel manufacturers, a diversified and instructive group of exhibits is being assembled, which will confirm much of the trade gossip about new designs, new products, and improvements in established products in the field. The program provides ample time for leisurely inspection of the displays without interference from the technical program.

In planning the program, special attention was also given to the schedule of plant-inspection trips. These have been timed for free afternoons. Visits have been arranged to the Cleveland Diesel Division of General Motors Corporation, the Cleveland Graphite Bronze Company, the Aluminum Company of America, and the National Advisory Committee for Aeronautics laboratory.

Social events include a luncheon on opening day, Wednesday, May 21; a buffet supper and social hour Wednesday evening, an exhibitors' social hour Thursday noon and the banquet on Thursday evening at which George Codrington, honorary chairman of the conference, will preside.

Those planning to attend the special lectures or the Conference itself are cautioned to reserve hotel rooms at their earliest convenience. This may be done by corresponding directly with Hotel Statler, Cleveland, Ohio, official A.S.M.E. headquarters. When doing so, refer to the Conference for prompt response.

Tentative Program

The regular program of the Conference will consist of four technical sessions, during which nine papers will be read. The tentative program follows:

TUESDAY, MAY 20

Lecture Course on Diesel Fuel Oils

9:00 a.m.

Lecture I

Production of Diesel Fuel Oils, by C. A. Rehbein, head, new process design section, Research and Development Department, Shell Oil Company, New York, N. Y.

12:00 noon

Luncheon

2:00 p.m.

Lecture II

Physical and Chemical Characteristics of Diesel Fuel Oils, by R. D. Pinkerton, research supervisor, process division, research and development department, Sinclair Refining Company, East Chicago, Ind.

8:00 p.m.

Lecture III

Combustion of Diesel Fuel Oils, by Dr. M. A. Elliott, assistant chief, synthetic and liquid fuels, Research and Development Division, U. S. Department of Interior, Bureau of Mines, Pittsburgh, Pa.

WEDNESDAY, MAY 21

Oil and Gas Power Conference

9:00 a.m.

Registration

12:15 p.m.

Keynote Luncheon

2:00 p.m.

Applications Session

Suggestions on Use of Combustion Engines in Locomotives, by G. E. Unger, professor, National School of Engineering, Lima, Peru. Some Aspects of Fuel Injection for Aircraft Engines, by Israel Katz, professor, Sibley School of Mechanical Engineering, Cornell University, Ithaca, N. Y.

The Results of Internally Cooled Supercharging, by R. H. Miller, chief engineer, four-cycle engine division, Nordberg Manufacturing Company, Milwaukee, Wis.

6:30 p.m.

Stag Supper

THURSDAY, MAY 22

9:00 a.m.

Fuels Session

Diesel Fuel-Oil Situation, by E. Miller, assistant to director, general laboratory, Research Department, Socony-Vacuum Oil Company, New York, N. Y.

A Comparison of Various Vegetable Oils as Fuels for Compression-Ignition Engines, by A. N. Baker, professor, and R. L. Sweigert, director, general engineering, Georgia School of Technology, Atlanta, Ga.

Is Fuel a Major Factor in the Smokeless Operation of a Locomotive or Stationary Diesel? by R. J. Bender, assistant to chief consulting engineer, Sinclair Refining Company, New York, N. Y.

2:00 p.m.

Inspection Trips

6:30 p.m.

Banquet

Speaker: E. Johnson, manager of engineering apparatus department, General Electric Company, Schenectady, N. Y.

Subject: What is New in Engineering

Awards will be presented to authors of significant papers presented before the Oil and Gas Power Division

FRIDAY, MAY 23

9:00 a.m.

Bearings Session

Sleeve-Bearing-Design Fundamentals for Diesel Applications, by W. E. Thill, design engineer, Federal-Mogul Corporation, Detroit, Mich.

Large Bearing, Design, Application, and Operation, by E. Crankshaw, assistant chief engineer, bearing design and application division, and G. W. Lapier, supervisor of metallurgical control, both of Cleveland Graphite Bronze Company, Cleveland, Ohio

1:30 p.m.

Inspection Trips

SATURDAY, MAY 24

9:00 a.m.

Bearings (II) Session

Diesel-Engine Bearings, by B. J. Esarey, district engineer, National Bearing Division, American Brake Shoe Company, St. Louis, Mo.

Behaviorism of Aluminum-Alloy Bearings in Diesel Engines, by D. B. Wood, development engineer, Cleveland Division, Aluminum Company of America, Cleveland, Ohio.

A.I.M.E. Holds World Conference in Connection With 75th Anniversary Celebration

MECHANIZATION has given man the key to the earth's mineral wealth, has almost completely displaced hand-operations equipment in the last 75 years, and has enabled one man to do the work of a thousand with ease, speed, and efficiency, according to Louis S. Gates, president, A.I.M.E., who spoke on "Techniques of Mineral Exploitation of the Future" before the World Conference on Mineral Resources, held in conjunction with the 75th Anniversary Celebration of the American Institute of Mining and Metallurgical Engineers at the Waldorf-Astoria Hotel, New York, N. Y., March 17 to 19, 1947.

During the digging of the Suez Canal, he said, sand was picked up by hand and carried away in rush baskets; today in the United States a power shovel can scoop up 40 cu yd at a time and load trains of 100-ton cars.

A helicopter equipped with the latest geophysical equipment, in a two-hour survey can accomplish as much as a 108-day conventional ground survey. Dredges are now constructed which will dig 125 ft below the water line and treat 15,000 cubic yards per 24 hr.

Addressing the 75th Anniversary Dinner, Spruille Braden, Assistant Secretary of State, said that "the greatest barriers to man's progress are those raised by the red and black fascists. Elsewhere in the world there probably is a plentitude of undeveloped and undiscovered mineral deposits. Most of the countries in which those properties lie have neither the capital nor the technical knowledge to explore, equip, and operate them. In the United States there is abundant capital and know-how."

"Private enterprise" he declared "is the best and in most circumstances the only really sound means to develop the known or unknown resources of a new country."

Upon conclusion of the dinner, the following medals and awards were presented: The William Lawrence Saunders Medal to LeRoy Saksich of Duluth, Minn.; Charles F. Rand Medal to George M. Humphrey of Pittsburgh, Pa.; Robert W. Hunt Medal to Harry K. Ihrig of Milwaukee, Wis.; Anthony F. Lucas Medal to Prof. William N. Lacey of the California Institute of Technology; the John E. Johnson, Jr., Award to Kurt Neustaetter of the Inland Steel Company; the Rossiter W. Raymond Award to William A. Johnson of the Clinton Laboratories, Oak Ridge, Tenn.

Honorary membership was awarded to Peter M. Anderson of South Africa; Charles Camsell, noted Canadian mining engineer; Charles A. Carlow of Scotland; Cecil Henry Desch of England; Sir William Fraser; John Robert Suman of New York; and Wong Wen-Hao, honorary member A.S.M.E., Chinese Minister of Economic Affairs.

Clyde Williams, director of Battelle Memorial Institute, Columbus, Ohio, was inducted into office as president. Louis S. Cates, the outgoing president, who presided, read a message from former President Herbert Hoover, a member of the Institute, in which he said that the engineering profession was "of transcendent importance in these times when the world needs production and more production."

"That is the engineer's function," the message added, "and it underlies our hopes not only of economic reconstruction but of world peace."

A.S.M.E. Manual Prepared on Civic Responsibility

A PROPOSED "Manual on Civic Responsibility Activities for A.S.M.E. Section and Student Branches" has been prepared by the A.S.M.E. Engineers Civic Responsibility Committee under the leadership of its chairman, Roy V. Wright, past-president and honorary member A.S.M.E., as a source book of ideas for members who want to know what they can do to encourage engineers in the exercise of their civic responsibilities.

The manual contains material for the individual member, the A.S.M.E. Sections, and the Student Branches. It contains a list of projects which have been inaugurated in various sections. It urges employers not to stand in the way of employees who are called upon to serve in public capacity. One of its features is the "Public Service Measuring Stick," questionnaire designed to awaken interest in public service. The Committee recommends it as a device to stimulate discussion. It was used successfully for this purpose by the A.S.M.E. Raleigh Section in preparation for a joint meeting with the Durham Engineering Society.

The manual was issued tentatively so that suggestions received from members can be incorporated in the final edition. Copies may be obtained from Dr. Wright, whose address is Simmons-Boardman Publishing Corporation, 30 Church Street, New York 7, N. Y.

Other members of the A.S.M.E. Engineers Civic Responsibility Committee are: F. A. Faville, Lillian M. Gilbreth, Paul W. Nordt, Jr., W. E. Johnson, and J. M. Sexton, who is junior adviser.

Metropolitan Juniors Hear Advice on Careers

"KNOW THYSELF" is still the cardinal principle for the junior engineer to keep in mind when he projects himself into the future and contemplates his place in industry, according to Edward Schulz, management consultant of the firm of Booz, Allen, and Hamilton, New York, N. Y., and co-author of the book "Elements of Supervision." Mr. Schulz spoke on "The Development of the Junior Engineer in Industry" before a meeting of the Junior Group of the A.S.M.E. Metropolitan Section on March 18, 1947.

The junior must evaluate honestly, his strength, weaknesses, education, how much money he wants, what he likes to do, what he dislikes to do, the measure of personal power and prestige he requires for contentment, the price of success, and the cost of failure; these should be his guides to a choice of goal.

Mr. Schulz emphasized that there were other fields for engineers than production. To find them, he advised juniors to become familiar with the principles of industrial organization and to make good use of the "channels of communication which connect the positions of similar responsibility" in which he finds himself.

In response to questions, he dropped the following bits of advice: (1) juniors should seek advancement in their own organizations rather than look to other employment; (2) the advancement of an engineer depends primarily upon himself, but he should not overlook other aids; (3) engineering societies can help juniors by encouraging companies to set up standards for engineering jobs to clarify the requirements for advancement.

L. M. Goldsmith, Honored

LESTER M. GOLDSMITH, member A.S.M.E., A.S.M.E. Melville Medalist, chief engineer, Atlantic Refining Company, Philadelphia, Pa., has received the decoration for exceptional civilian service for his contributions to the installation of an oil pipe line under the English Channel preceding the invasion of Normandy—the famed "Operation Pluto."

The presentation was made in Washington, D. C., by Lieut. Gen. R. A. Wheeler, Chief of Engineers of the U. S. Army. The citation accompanying the medal states the award was made to Dr. Goldsmith "for exceptional service with the Office of the Chief of Engineers during World War II. His outstanding performance in co-ordinating specifications for and procuring pumping equipment and lead cable essential to installing a petroleum pipe line across the English Channel contributed to the successful prosecution of the War."

Boiler Code Committee Honors E. D. Grimison

AS AN expression of its appreciation of the work of the late Edwin D. Grimison, member A.S.M.E., executive assistant, The Babcock and Wilcox Company, New York, N. Y., the A.S.M.E. Boiler Code Committee passed the following resolution at its meeting of Feb. 14, 1947:

WHEREAS the Boiler Code Committee has learned with profound sorrow of the death of Edwin D. Grimison on Jan. 11, 1947; and

WHEREAS he did much to help the Committee and the results of his valuable work are incorporated in its rules; and

WHEREAS he was honored and admired for his technical achievements and his loyalty and conscientiousness, imbued with a spirit of good fellowship and a kindly personality, has endeared him to all who knew him;

Be It Resolved that the Boiler Code Committee express its deep regret for his loss, and extend its sympathy to the members of his bereaved family; and

Be It Further Resolved that these resolutions be spread upon the minutes of this meeting and a copy be sent to his family.

While not a member of the Boiler Code Committee, Mr. Grimison had served as an alternate for several years in the absence of a Committee member and had variously contributed to its work. He had been active in the Committee's study of increased stress allowances for boiler plate, had assisted in the revision of the tables for boiler tubes, and had worked with the Sub-Committee on Material Specifications.

LIEUT. GEN. R. A. WHEELER (*left*) PRESENTS CIVILIAN SERVICE AWARD TO L. M. GOLDSMITH (*right*)

Franklin Institute Honors E. G. Ackart

EVERETT G. ACKART, member A.S.M.E., former chief engineer E. I. du Pont de Nemours Company, Inc., has been awarded the Newcomen Medal of The Franklin Institute "in consideration of his long and successful career of forty years in designing industrial steam plants."

Purdue University Backs E.J.C. Book Project

AS ITS part in the E.J.C. project for rebuilding the war-devastated libraries of the world, the Student Engineering Council of Purdue University, Lafayette, Ind., recently "adopted" the Cebu Institute of Technology, Cebu City, Island of Cebu, Philippines, and inaugurated a book-collecting campaign for rehabilitation of its war-damaged library.

In a letter to the E.J.C. Committee on International Relations, Amancio A. Alcordo, dean of the Institute, wrote, "It is gratifying to note that people who had suffered materially and educationally could still look forward to the American public for help along the rehabilitation of our schools in the Philippines. The school is looking forward with great anticipation for the coming of the much needed help to our library."

As a graduate of Purdue University, Dean Alcordo expressed pride and pleasure in the initiative of the "boilermakers."

He said that the first step in the rebuilding of the schools in Cebu City, which is still in ruins, is the rehabilitation of the library. Schools are still housed in temporary buildings, nipa shacks, and army provisionary buildings. "We would rather stay even outdoors for our classrooms so long as we can complete the other facilities for instructions," he said.

When the E.J.C. books arrive they will be made available to the students of the Institute and other educational institutions in Cebu City and the neighboring provinces.

A.S.M.E. Calendar

of Coming Events

May 21–24, 1947
A.S.M.E. Oil and Gas Power Division Meeting
Cleveland, Ohio

May 26–29, 1947
A.S.M.E. Aviation Division Meeting
Los Angeles, Calif.

June 12–13, 1947
A.S.M.E. Wood Industries Division Meeting
Madison, Wis.

June 16–19, 1947
A.S.M.E. Semi-Annual Meeting
Chicago, Ill.

June 23–25, 1947
A.S.M.E. Applied Mechanics Division Meeting
Schenectady, N. Y.

Sept. 1–4, 1947
A.S.M.E. Fall Meeting
Salt Lake City, Utah

Sept. 8–9, 1947
A.S.M.E. Instruments and Regulators Division Meeting
Chicago, Ill.

Oct. 6–8, 1947
Petroleum Committee of the A.S.M.E. Process Industries Division Meeting
Houston, Texas

Oct. 20–22, 1947
A.S.M.E. Fuels Division Meeting
Cincinnati, Ohio

Dec. 1–5, 1947
A.S.M.E. Annual Meeting
Atlantic City, N. J.

J. B. MacNeill to Receive 1946 Lamme Medal

THE 1946 Medal of the American Institute of Electrical Engineers has been awarded to John B. MacNeill, manager of the switchgear and control division, Westinghouse Electric Corporation, "for his foresight, leadership and creative contribution in the development of switching equipment."

New Journal Planned by British and American Scientists

A NEW quarterly journal, *Human Relations*, organized to report the work done in the social sciences, including community organization, industrial relations, mass education, and administrative management, has been announced jointly by the Tavistock Institute of Human Relations, London, England, and the Research Center for Group Dynamics, Massachusetts Institute of Technology, Cambridge, Mass. The first issue will appear shortly.

The journal will be edited on both sides of the Atlantic by two editing committees drawn from the staff of the two organizations. The editors will be guided by two advisory boards, one in each country, composed of members who represent the different social sciences.

The Tavistock Institute of Human Relations is a newly organized group of British psychiatrists and other social scientists who are engaged in a broad program of social research. The main task of the Research Center for Group Dynamics is the development of concepts and theories of group dynamics, and is designed to train workers in theoretical and applied fields of social studies.

Because of mutual fields of investigation and mutual attitudes toward the future of social sciences, it is expected that co-operative editing of the journal will channel work done in each country into one journal for comparative study at an international level.

Contributions and correspondence should be addressed to *Human Relations*, Research Center for Group Dynamics, Massachusetts Institute of Technology, Cambridge 39, Mass. Cost of subscription is $7 per year.

President O'Brien's Appeals Bring Liberal Comment and Aid

A.S.M.E. members responded liberally to the three appeals addressed to them by President Eugene W. O'Brien in his letter dated Jan. 17, 1947, which contained: (1) A progress report on E.J.C. activities for the year 1945–1946; (2) a request for members to allow the Society to remove their names from the mailing lists of Transactions and *Journal of Applied Mechanics;* and (3) a request for books and periodicals to be distributed among the libraries of the war-devastated areas of the world.

Of the 22,000 members who received the letter, some 4000 made replies regarding one or more of the appeals.

With regard to the progress report on E.J.C. activities, 450 members made some comment. The comments ranged from "Keep up the good work!" to lengthy suggestions for increasing the effectiveness of E.J.C. efforts. In general, those who replied expressed considerable interest in E.J.C. activities—particularly the economic-status survey and the proposed manual on collective bargaining—though many deplored the fact that the activities of the Council are not more widely publicized.

As a result of the request for members to allow the Society to remove their names from the mailing lists of Transactions and *Journal of Applied Mechanics*, 3870 members agreed to be dropped from one or both of these lists. Of this number, 2718 agreed to give up both publications, 349 agreed to give up *Transactions* only, and 803 agreed to give up *Journal of Applied Mechanics* only. Thus 3057 names have been removed from the Transactions list, and 3521 from the *Journal of Applied Mechanics* list.

In answer to the request for books and periodicals for distribution among the libraries of war-devastated areas, 309 members stated that they have such material which they wish to contribute. As yet no exact figures are available, but it is estimated that the supply of books and periodicals available for such distribution will be increased by 20 per cent as a result of this recent A.S.M.E. contribution.

R.E.S. Celebrates Fiftieth Anniversary

ON March 22, 1947, the Rochester Engineering Society, Rochester, N. Y., celebrated its fiftieth anniversary with a dinner attended by 600 engineers and guests, during which it paid a warm personal tribute to its first president, Edwin A. Fisher, now in his one hundredth year.

Following the dinner, Louis B. Cartwright, city manager, Rochester, N. Y., related how the Society had served the community, and praised the work of Mr. Fisher who for many years served Rochester as city engineer and who is still active in an advisory capacity.

Lewis B. Smith, member A.S.M.E., chairman, Fiftieth Anniversary Dinner Committee, and Walter S. Lee, president, R.E.S., reviewed the history of the Society and recalled the work of past-presidents, many of whom were present.

The main speaker of the evening was Charles F. Kettering, fellow A.S.M.E., A.S.M.E. Medalist, 1940, and vice-president, General Motors Corporation, who spoke on "Faith as a Fundamental of Human Progress."

Dr. Kettering was preceded by Roy S. Anderson, Stromberg-Carlson Company, who gave a demonstration on wire recording.

As an organization for public service, the Rochester Democrat and Chronicle declared that the city "has no more vital or useful organization," and that the Society has been "an active forum for discussion of public affairs as they touch engineering or as engineering touches them."

Sixth Edition of "Who's Who in Engineering" to Appear in Fall

THE Engineers Joint Council has appointed an advisory committee of 10 members to aid in the compilation of the sixth edition of "Who's Who in Engineering" now being prepared under the editorship of W. S. Downs of the Lewis Historical Publication Company, for publication in the fall.

Revision of the 1941 edition is being undertaken at the present time in order to record the wartime and postwar activities of the engineering leadership.

A. A. Potter, past-president and honorary member A.S.M.E., is chairman of the Advisory Committee.

For inclusion in the volume, an engineer must qualify for at least one of the three classifications established by the committee. These are: (1) Engineers of outstanding and acknowledged professional eminence; (2) engineers of at least ten years' active experience, of which at least five years have been in responsible charge of important engineering work; (3) teachers who have taught engineering subjects in colleges or schools of accepted standing for at least ten years, of which at least five years have been in responsible charge of a major engineering course in such college or school. Military assignments will have proper consideration in Groups 2 and 3.

Biographical sketches for the sixth edition will be accepted up to June 1, 1947.

Tentative Program for A.S.M.E. 1947 Wood Industries Conference, Madison, Wis., June 12–13, 1947

THE Wood Industries Division of The American Society of Mechanical Engineers will hold its 1947 National Conference at the U. S. Forest Products Laboratory, Madison, Wis., June 12 and 13, 1947.

The mornings of both days will be given over to technical sessions, while the afternoons will be devoted to inspection of the Forest Products Laboratory and conferences with the laboratory staff.

The main social event will be a banquet at Hotel Loraine, Thursday, June 12. A prominent figure in the wood industries will address the conference on a timely subject. A sound film on high-frequency heating will also be shown.

The Conference has been planned to precede the A.S.M.E. 1947 Semi-Annual Meeting by a few days so that members attending the conference may also participate in the events of interest planned by the Wood Industries Division for the Chicago Meeting. These will include an informal get-together on Sunday evening, June 15, also a Wood Industries Division luncheon and an inspection trip to the Onsrud Machine Works, Inc., on Monday, June 16.

A tentative program follows:

THURSDAY, JUNE 12

Morning Session

An Explanation of the Longitudinal Shrinkage of Wood Based on the Interconnected Chain Molecule Concept of Cell Wall Structure, by Robert A. Cockrell, associate professor, school of forestry, University of California, Berkeley, Calif.

Lumber Grading, Inspection, and Specification, by L. W. Smith, wood technologist, U. S. Forest Service, Washington, D. C.

High-Frequency Edge Gluing, by Burdette Wilkins, consulting engineer, Ridgewood, N. J.

Afternoon Session

Tour through Forest Products Laboratory.

Banquet Session

Hotel Loraine

Speaker: to be announced.
Sound Film: High-Frequency Heating.

FRIDAY, JUNE 13

Morning Session

A Development Center for Forest-Fire Control Equipment, by Ira C. Funk, director, Forest Service Equipment Development Center, Arcadia, Calif.

Tennis Rackets, by James M. Tyman, research engineer, A. G. Spaulding and Bros. Inc., Chicopee, Mass.

Honeycomb Construction, by O. S. Tuttle, U. S. Plywood Corporation, New Rochelle, N. Y.

Utilization of Wood Waste, by Roger R. Smith, president, Wood Corporation, Greenfield, Mass.

Afternoon Session

Conference with members of Forest Products Laboratory staff.

A.S.M.E. Members Asked to Express Stand on Labor Legislation

TO PROVIDE Congressional legislators with authoritative information on the question of how engineers feel about complete exclusion of all professional employees for the provisions of any proposed national labor legislation, the A.S.M.E. mailed a questionnaire to all members of the Society, seeking the following specific information:

(1) How many members do and how many do not favor inclusion of professional employees under a labor law with special safeguards; (2) How many members do and how many do not favor exempting professional employees from the provisions of any national labor act.

Upon analysis of the heavy return which reflects deep interest in the subject, the results will be passed on to the Engineering Societies Panel on Labor Legislation, on which William F. Ryan, fellow A.S.M.E., Stone and Webster Engineering Corporation, Boston, Mass., is representing the A.S.M.E.

The replies are being analyzed for supervisory, nonsupervisory employees, and consultants grades of membership and age status.

A similar questionnaire was mailed to all members of the founder societies and other engineering organizations co-operating in the Panel initiated by the E.J.C. The total returns will provide a specific answer to questions raised by Washington legislators when the Panel appeared before hearings of the Senate Committee on Labor and Welfare and the House Committee on Education and Labor early in March, 1947.

The magnitude of the returns, especially the number from engineers in nonsupervisory positions, will have an important bearing on the weight Congressional Committees place on the stand to be taken by the Engineering Societies Panel at future hearings.

Belgian Engineers Honor H. A. Schwartz

H. A. SCHWARTZ, member A.S.M.E., manager of research, National Malleable and Steel Castings Company, Cleveland, Ohio, has been elected to honorary membership in the Association Technique de Fonderie de Belgique, it has been announced.

In a letter to Mr. Schwartz notifying him of the honor, Edwin Cummins, general secretary of the Association, said, "In view of your world-wide reputation as a scientist and the constant influence you have exerted on our own research commissions for many years, we feel that this recognition comes as a just award."

The Institution of Mechanical Engineers to Celebrate Centennial Year June 8 to 13, 1947

THE A.S.M.E. with other scientific and engineering societies all over the world are preparing to hail The Institution of Mechanical Engineers on the occasion of its Centenary Celebrations to be held in London, June 8 to 13, 1947. Organized in 1847 under the presidency of George Stephenson, pioneer locomotive engineer, the Institution has encouraged advancement of engineering science, and promoted research in mechanical engineering by providing grants and organizing research committees. Its requirements for membership have largely determined the educational requirements of the engineer in Britain. Much of the early history of mechanical engineering is recorded in its Proceedings. As a model for other societies, including the A.S.M.E., the Institution has served as a guiding light to engineers all over the world.

The A.S.M.E. is sending as official delegates to the Centenary Celebration, Alfred Iddles, past-vice-president and fellow A.S.M.E., and director, The Babcock and Wilcox Company, New York, N. Y., and A. G. Christie, past-president and honorary member A.S.M.E., professor of mechanical engineering, Johns Hopkins University, Baltimore, Md. Dr. Christie, who is also an honorary member of the Institution, will be one of the five American engineers among the eight A.S.M.E. members and fellows, who will lecture during the technical sessions of the Centenary Conference.

Other A.S.M.E. engineers who will participate in the Centenary Conference follow: Mechanical Plants for Power Stations Session: Adolph Meyer, member A.S.M.E., Brown Boveri and Company, Baden, Switzerland.

Railroad Power-Plant Session: Paul Kiefer, member A.S.M.E., chief engineer, motive power and rolling stock, New York Central System.

Aeroplane Propelling Machinery Session: H. R. Ricardo, honorary member A.S.M.E., consulting engineer, Ricardo and Company, Sussex, England; and W. Julian King, member A.S.M.E., department of mechanical engineering, Cornell University, Ithaca, N. Y.

Refrigeration, Air Conditioning, Heating and Ventilation Session: Willis H. Carrier, honorary member A.S.M.E., chairman, Carrier Corporation, Syracuse, N. Y.

Marine Power-Plant Session: T. W. F. Brown, member A.S.M.E., The Parsons and Marine Engineering Turbine and Research Development Association, Wallsend-on-Tyne, England.

Education and Practical Training of Mechanical Engineers Session: R. E. Doherty, fellow A.S.M.E., president, Carnegie Institute of Technology, Pittsburgh, Pa.

Commencing with a Thanksgiving Service at Westminster Abbey on Sunday, June 8, the Centenary Celebrations will continue through the week with conference sessions in the mornings, visits to industrial plants in the afternoons, and social functions and special lectures in the evenings. The celebrations will conclude with a banquet on Friday, June 13, at the Guildhall, London, where the Prime Minister and the Lord Mayor of London will be among the principal guests.

Thirty-four years before the founding of the A.S.M.E., George Stephenson, British railway and locomotive engineer was rejected for membership in The Institution of Civil Engineers because, according to some, "he was merely a blacksmith." The resentment aroused by this action among the growing fraternity of locomotive engineers led to the proposal for an institution devoted to the needs of mechanical engineers. Accordingly, on Nov. 18, 1846, a committee met and approved rules and regulations for the new Institution and on Jan. 27, 1847, the first general meeting attended by 100 members was held in the Queen's Hotel, Birmingham, England. Fifty years later, membership in the Institution was 2700; today it has reached 22,000.

In 1880 when Thurston, Holley, and others were organizing the A.S.M.E., American mechanical engineers looked upon the Institution of Mechanical Engineers as a working model of an engineering organization worthy of emulation. After studying the organizational structure of many societies, A.S.M.E.

founders adopted a constitution which, in effect, was a copy of the constitution of The Institution.

Even today, after several constitutional modifications, the stamp of the Institution of Mechanical Engineers is still plainly visible in the administration of A.S.M.E. affairs. The Institution, like the A.S.M.E., has a council of more than 20 members, numerous local sections, and carries on its technical programs through an organization of special groups similar to the A.S.M.E. Professional Divisions.

The headquarters building of the Institution is a magnificant structure with a massive stone facade, lofty columns, and an entrance surrounded by elaborately chiseled embellishments. The building faces St. James Park.

One of the early rules of the Institution which the A.S.M.E. did not adopt, required that every member "shall lay at least one communication per annum before the society, tending to advance professional knowledge, or shall pay one pound fine towards the Library Fund." This rule is no longer in force.

Through the years, the A.S.M.E. and the Institution have encouraged co-operation and communication between engineers on both sides of the Atlantic. Recently, the A.S.M.E. reprinted for distribution in the United States, twelve lectures on "The Development of the British Gas Turbine Jet Unit" originally presented before the Institution.

Actions of the A.S.M.E. Executive Committee

At a Meeting Held at Headquarters, March 21, 1947

A MEETING of the Executive Committee of the Council was held in the rooms of the Society, March 21, 1947. There were present: Eugene W. O'Brien, chairman, J. N. Landis, vice-chairman, F. S. Blackall, Jr., A. C. Chick, A. R. Mumford, K. W. Jappe, treasurer, C. E. Davies, secretary, and Ernest Hartford, executive assistant secretary.

Survey Committee

Upon recommendation of the Board on Technology, it was voted to discharge with thanks the Survey Committee which was organized "to analyze present activities, develop scheme of activities and publication" and to assign its functions to the Board of Technology.

Handbook on Screw Thread Standards

In connection with the proposed Handbook on Screw Thread Standards and the Society's obligation to prepare material for the international standardization project for screw threads, it was voted to appropriate a loan from the development fund for the necessary staff work. It was understood that the loan would be repaid from the sales of the handbook.

Certificates of Award

Certificates of Award for the following were approved: Committee on Relations With Colleges: R. P. Reece, H. J. Brown, Herbert Kuenzel, H. R. Pearson, G. L. Sullivan.

War Production Committee: James L. Walsh, G. M. Barnes, J. A. Furer, K. H. Condit, C. F. Dietz, Sol. Einstein, D. S. Ellis, W. M. Sheehan, T. H. Wickenden, W. L. Batt, C. E. Brinley, H. V. Coes, H. N. Davis, W. C. Dickerman, Gano Dunn, W. F. Durand, W. S. Finlay, Jr., R. E. Flanders, R. M. Gates, K. T. Keller, David Larkin, F. T. Letchfield, O. B. Lyman, W. H. McBryde, T. A. Morgan, R. C. Muir, E. A. Muller, T. E. Murray, W. I. Westervelt, and A. C. Willard.

Wilfred E. Johnson "for his efforts in the formation of the Fort Wayne Section."

P. T. Onderdonk "for his work in connection with Production Clinics."

Past-chairman of Sections: Kansas City, E. L. McDonald; Louisville, O. C. Krause, Jr., F. P. Shannon, H. V. Heuser, W. F. Lucas, Melvin Sack, H. H. Fenwick, L. R. Jackson.

Engineering Societies Yearbook

It was noted that the E.J.C. had approved sponsorship of the Engineering Societies Yearbook, to be prepared, published, and financed by the A.S.M.E.

Labor-Legislation Panel

During the recent appearance of the Engineering Societies' Labor-Legislation Panel before the House and Senate Committees, it became apparent that some of the legislators desire to enact legislation to eliminate professional men from all phases of collective bargaining. Upon recommendation of William F. Ryan, A.S.M.E. representative on the Panel, it was voted to submit a questionnaire to all members of the Society for an expression of opinion on this question.

Appointments

The following appointments were approved: Board on Public Affairs: W. E. Johnson; Junior Committee: Philip Allen, Chas. H. Carman, Jr., Donald E. Jahncke, George B. Thom, and H. C. Thuerk; Special Research Committee on Properties of Gases and Gas Mixtures: Joseph H. Keenan and Dr. Frederick G. Keyes.

P.T.C. Committee No. 18 on Hydraulic Prime Movers: Ray S. Quick; Committee on Manual of Practice: S. Logan Kerr, Albert C. Wood, and J. Harland Billings; A.S.A. Sectional Committee on Numbering System for Antifriction Bearings: Louis C. Fisk and David H. Ware.

Gantt Medal Board of Award: Henry P. Dutton; American Year Book Corporation: George A. Stetson.

The Institution of Mechanical Engineers, official delegates to Centenary Celebration, Alfred Iddles and A. G. Christie.

American Institute of Mining and Metallurgical Engineers, official delegate to 75th Anniversary Celebration, A. R. Mumford.

Rice Institute, inauguration of president, James M. Robert and Willis R. Woolrich.

American Academy of Political and Social Science, fifty-first annual meeting, Philadelphia: J. H. Harlow, S. T. MacKenzie, and G. M. Muschamp.

National Conference on UNESCO, Philadelphia, Pa.: R. M. Gates and Stewart E. Reimel.

Sections

Birmingham Section Hears J. I. Yellott

On Feb. 24 at the Tutwiler Hotel, Birmingham, Ala., J. I. Yellott, member A.S.M.E., director of research, Locomotive Development Committee, Baltimore, Md., gave a talk on "Coal-Burning Gas Turbine for Locomotive Service." He discussed the coal-burning gas-turbine locomotive and the research and manufacturing difficulties involved in its development. Questions were asked about how this type of power plant compared to that of the Diesel and steam locomotive with reference to efficiency, first cost, operating cost, and maintenance. One hundred were present.

"Wire Rope: Its Manufacture and Use," was the subject of a talk by David Larkin, fellow A.S.M.E., vice-president, Broderick and Bascom Rope Company, St. Louis, Mo., on March 17 at the Tutwiler Hotel. Forty-two were in the audience.

Metal-Cutting Temperatures Topic at Central Illinois Section

A joint meeting with the local A.S.M.E. Section was held on March 14 at the Jefferson Hotel, Peoria, Ill. Prof. K. J. Trigger, member A.S.M.E., of the University of Illinois, gave a talk on "Metal-Cutting Temperatures," in which he told of experimental work being done at his university on measuring the temperatures of the contact tool and the chip of the work being cut. He explained the method used to obtain the temperature, and told of some of the results. Thirty-five members and 65 visitors were present.

Power in Paper Industry Subject at Boston Section

On March 27 at the Hotel Commander, Cambridge, Mass., before an audience of 160,

R. R. Baker of the Westinghouse Electric Corporation, gave a talk entitled "Power in the Paper Industry." Mr. Baker made an interesting survey of the development of the papermaking industry, briefly outlined the mechanical and chemical methods of production, and discussed fully the power and steam requirements of the two types. This was followed by a number of slides showing various installations and views of the equipment. An open discussion followed the talk on which many interesting points pertinent to the power problem were brought out.

Central Indiana Section Has Dinner Meeting

On March 21 at the Athenaeum, Indianapolis, Ind., a dinner meeting was held, attended by 30 members and 10 guests. Carl C. Wilcox, head of the mechanical school, Notre Dame University, gave an illustrated talk entitled "Some Engineering Features of the Canol Project." Mr. Wilcox, who was chief engineer on the Canol project, told of his experiences on this job. The work was begun in 1942 and included a 600-mile pipe line designed to carry 5000 bbl per day. The job opened up in the spring of 1944 and at a cost of 35 million dollars, carried a line across the roughest country on this continent.

Central Illinois Section Meets With Waterloo Technical Society

On March 19 a joint meeting was held with the Waterloo Technical Society, at Waterloo, Iowa. One hundred and fifty-nine were present. The Waterloo Technical Society supplied the speaker, B. H. Van Dyke, manager of the new products department of the Elliott Company. His subject was "The Gas Turbine, Present Status and Future Prospects." At this meeting election of officers of the Section for the coming year was held, with the following result: Glen Boylan, R. A. Engel, J. S. Mikovec, M. P. Cleghorn, executive committee members for a two-year term. Officers of the executive committee for the year July 1, 1947 to July 1, 1948, are: Glen Boylan, chairman; Merlin Hansen, vice-chairman; Earl D. Hay, secretary-treasurer.

Stoker Fuel Beds, Subject at Central Pennsylvania Section

On March 6 at the Pennsylvania State College, State College, Pa., Otto de Lorenzi, member A.S.M.E., director of education, Combustion Engineering Company, Inc., New York, N. Y., spoke on "A Study of Stoker Fuel Beds." He used motion pictures to illustrate his talk. The single- and multiple-retort, chain-grate, and spreader stokers were discussed. The relative merits of each in regard to the type of coal that can be burned was clearly presented. Overfire pictures, in color, taken at the rate of 3000 per sec, revealed many heretofore unknown factors of combustion. Eighty were present.

MRS. T. S. MCEWAN VISITS A.S.M.E. MILWAUKEE SECTION

(*Left to right:* Ted Wetzel, Max Ruess, Mrs. McEwan and Harold Haywood.)

Jet Engine Discussed at Cleveland Section

On March 13 in the Cleveland Engineering Society building, Cleveland, Ohio, A. H. Redding, junior member A.S.M.E., Westinghouse Electric Corporation, gave a talk on "Developing a Jet Engine." The talk was illustrated. One hundred members and 200 visitors attended.

Cincinnati and West Virginia Sections Hold Joint Meeting

The Cincinnati Section joined with the West Virginia Section in a joint meeting on March 28 at the Schneider Memorial, Cincinnati, Ohio, at which time Steward M. Lowry, of Booz, Allen, and Hamilton, discussed "A New Type of Business Audit." Mr. Lowry covered the eight major functions (nonfinancial operations), general administration, finance and control, sales, products, manufacturing, personnel, purchasing, advertising, and promotion. He showed how these may be subdivided into 60 to 80 minor classifications, and audited by trained specialists in much the same way as the financial audits are handled. One hundred and fifty were present.

Fairfield County Section Hears W. T. Piper

On March 19 at the Hotel Barnum, Bridgeport, Conn., an audience of 90 heard W. T. Piper, president, Piper Aircraft Corporation, Lock Haven, Pa., speak on "Private Flying." Declaring that "since the invention of the wheel no other invention will have as much impact on our lives as the airplane," Mr. Piper described the effect on this country when everyone can fly easily and economically. "No city in the United States," he said, "will be isolated or, in the event of war, protected from aircraft." Mr. Piper, who manufactured the "Flying Jeep" for the armed forces during the war, described the multiple uses for a small "personal" plane that anyone could fly. About 35 of the members and guests of the meeting remained after Mr. Piper's talk to discuss with him the future of small-plane flying in the Bridgeport area.

Dayton Section Attends Science Show

On March 19 in the National Cash Register Company's auditorium, Dayton, Ohio, before an audience of 2100, C. Edward Gluesing gave an excellent commentary on the General Electric Company's science show, the "House of Magic." The show has been freshened by the incorporation of recent developments in the fields covered and striking demonstrations were made of various electrical, electronic, and other phenomena.

Two Important Meetings Held by Milwaukee Section

On March 6 Ted Wetzel, general chairman of the 1948 Semi-Annual Meeting, called a meeting of the wives of members of the Section for the general purpose of obtaining their assistance in laying plans for entertaining the ladies attending the 1948 meeting. Before the meeting adjourned all present indicated a desire to organize a Milwaukee Section Auxiliary and request for a charter was forwarded to national headquarters.

On March 12 the Section was host to the Rock River Valley Section and the Railroad Society of Milwaukee, at its monthly dinner meeting. Over 100 members, their wives, and guests were present at the dinner, and attendance swelled to over 200 for the technical discussions which followed. Charles Kerr, Jr., consulting transporation engineer, Westinghouse Electric Corporation, and F. P. Grutzner, member A.S.M.E., engineer in charge of Diesel locomotive design, Fairbanks, Morse and Company, were the main speakers. An open-forum discussion followed the talks.

John I. Yellott, Speaker at New Haven Section

On March 12 a dinner meeting was held at Ceriani's Cafe Mellone, New Haven, Conn., at which John I. Yellott, member A.S.M.E., director of research, Locomotive Development Committee, Baltimore, Md., spoke on "The Coal-Burning Gas Turbine." Mr. Yellott spoke extemporaneously, giving a brief history of gas-turbine development and considerable detail on his current work on a practical coal-burning gas turbine for locomotive application. Fifty-five were present.

Plainfield Section Hears Talk on Coal-Fired Gas Turbines

An audience of 63 heard Charles F. Kottcamp, assistant to director of research, Locomotive Development Committee, speak on "Coal-Fired Gas Turbines," at the Elks' Club in Elizabeth, N. J., on March 19. Mr. Kottcamp covered thermal efficiency and economics of various types of prime movers applicable to locomotives using solid and liquid fuels; problems with solid fuel; drying; crushing; pressurizing; pulverizing; ash removal before admission to turbine; alternate designs of pressurizers; combustion chamber, separator, blower, and arrangement of unit for open cycle.

President O'Brien Speaks at North Texas Section

On March 6 a joint meeting was held with the A.I.E.E., at the Dallas Power and Light Company Building, Dallas, Texas, with 44 present. Eugene W. O'Brien, president A.S.M.E., spoke on the "Unification of Engineers," and led a discussion of E.J.C. activities and the co-operation of members of the engineering profession. Audience interest and participation was so intense that the meeting almost overlapped President O'Brien's train departure.

"Industrial Productivity" Subject at Rock River Valley Section

On March 20 at the Hotel Hilton, Beloit, Wis., an audience of 24 members and 23 guests heard F. A. Mattka, director, Research and Development Bureau, Albert Ramond and Associates, speak on "Industrial Productivity." Mr. Mattka attempted to separate share due to workers' increased productivity from the share due management for improvements in machine tools and layout.

Col. J. L. Walsh, Speaker at Providence Section

On March 4 in the Providence Engineering Society Building, Providence, R. I., Col. J. L. Walsh, president of the Army Ordnance Association, spoke to an audience of 45. Colonel Walsh, who holds the Crozier Gold Medal for his contributions to the defense program of the country, said that the influence of the Army and the Navy is very slight in Congress when it comes to obtaining money for national defense, "especially in competition with pork-barrel legislation and boondoggling bills." He further said that it is the duty of civilians to appreciate the necessity for substantial appropriations for providing weapons because civilian indifference begets congressional parsimony. "We civilians ought to quit criticizing the regular Army and the regular Navy," he stated, "and get busy ourselves. It may be later than we think." He added that on every decisive battlefield American-designed and American-manufactured ordnance was the critical and controlling factor in saving civilization.

Past-Chairmen's Night at St. Louis Section

At the meeting on March 28 which was celebrated as "Past-Chairmen's Night," eight of the 19 past-chairmen of the Section were present and were presented with "Certificates of Award," by T. S. McEwan, vice-president, A.S.M.E. Region VI. These eight past-chairmen were: F. A. Berger, W. E. Bryan, L. C. Farquhar, David Larkin, A. L. Heintze, R. W. Merkle, Herbert Keunzel, and Paul H. Buxton. F. A. Faville of the Civic Responsibility Committee, gave an interesting paper devoted to training for citizenship. A discussion followed. All agreed it was the most interesting meeting of the season.

Modern Industrial Boilers, Talk at Savannah Section

On Feb. 28 in the Chatham Room, Hotel De Soto, Savannah, Ga., an audience of 40 heard Claude L. Huey, member A.S.M.E., sales engineer, Babcock and Wilcox Company, Atlanta, Ga., speak on "Modern Industrial Boilers." D. R. Yopp, member A.S.M.E., Atlanta manager of the Babcock and Wilcox Company in Savannah, led the discussion.

Southern California Section Holds Three Meetings

The meeting on March 6 at the Rio Hondo Country Club, Los Angeles, Calif., featured Dean L. M. K. Boelter, member A.S.M.E., college of engineering, University of California, who gave a talk on "Problems of Heat Transfer." Dean Boelter explained the various methods of calculating problems, research to date, and the future research required. In conclusion, he stated that our graduate students are not interested in research routine, and our research source has been cut off. There were 148 members and 161 guests present.

The Petroleum Division of the Section held a meeting on March 13 at the Elks Club, Los Angeles, Calif., attended by 91. M. C. Alcarn, assistant pipe-line manager, Shell Oil, Inc., was the speaker, and his subject was "Ten Years' Experience With Underground Uncoated Pipe Lines." He discussed the 260-mile pipe line from S. San Joaquin Valley to Shell refinery in San Francisco Bay area completed in 1936. Detailed charts were shown.

On March 28 a field trip was made to the Vernon Plant, where the operation of two paper mills producing 200 tons daily was seen. A talk was given by Ed A. Wilhelm, chief engineer, on "Modern Manufacturing Methods of Fiberboard Products." Ninety-seven made the trip.

Aspects of Automatic Control Subject at Southern Tier Section

On March 31 at the Arlington Hotel, Binghamton, N. Y., William H. Steinkamp gave a talk on "Some Practical Aspects of Automatic Control." The speaker pointed out that the benefits gained from automatic control were improved product quality and uniformity, increased production rates, and cost reduction in labor, materials, and space requirements. Typical applications were shown and discussed. Forty were present.

President O'Brien Visits South Texas Section

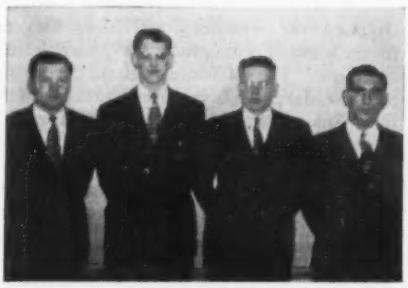
At the meeting on March 7 at River Oaks Country Club and Rice Hotel, Houston, Texas, E. W. O'Brien, president A.S.M.E., explained the policies, organization, and aims of A.S.M.E., and gave counsel to all members of the Section. Fifty members were present.

Talks on Diesel-Electric Drive Heard by Utah Section

On March 3 at the University of Utah, Salt Lake City, Utah, two speakers, R. H. Stocking, and Burns S. Hansen, engineering department, General Electric Company, developed the history of Diesel application to railroad use, with

EXECUTIVE COMMITTEES OF THE A.S.M.E. WESTERN WASHINGTON SECTION AND THE A.S.M.E. UNIVERSITY OF WASHINGTON STUDENT BRANCH

(*Front row:* J. M. Consley, chairman, Western Washington Section; R. W. Crain, Sr., secretary-treasurer of the Section, and honorary chairman, University of Washington Student Branch; and Kenneth W. Decker, chairman, student branch. *Back row:* Fred A. Thorn, vice-chairman, student branch; Fred R. Young and Fairman B. Lee of the Section; and Larry Hoffman, student branch.)



WINNERS IN THE STUDENT-PAPER CONTEST AT THE WESTERN WASHINGTON SECTION
(*Left to right:* S. L. Bryant, Donald E. Anderson, Richard Holt, and Milan A. Neslin.)

figures and charts. The basic usefulness of Diesel-electric drive was shown. The principle and application of dynamic braking as applied to railroad equipment, and the General Electric type of control for Diesel-electric locomotives were illustrated with slides, charts, and some actual pieces of the control system. Fifty-six were in the audience.

Syracuse Section Meeting Discusses Young Engineers

At the meeting on March 19 in the Technology Club, Syracuse, N. Y., Robert Casson, George Hammon, and June Kath, three student members of the Syracuse University branch led a discussion on "Problems of the Young Engineer." A wide variety of problems were covered, with the majority of the group participating in the discussion. Problems of G.I. students, and women in engineering careers were especially noted as major problems. Thirty-five were present.

Washington, D. C., Section Hears John I. Yellott

On March 13 a dinner meeting was held at the Harrington Hotel, Washington, D. C., followed by a program in the Potomac Electric Power Company auditorium. The speaker was John I. Yellott, member A.S.M.E., who gave a talk on "The Coal-Burning Gas-Turbine Locomotive." Mr. Yellott, who is director of research for the Locomotive Development Committee, Baltimore, Md., discussed the experience with one gas-turbine locomotive now in operation and described details of two turbines at present on order for the Committee.

Student Contest at Western Washington Section

On March 5 the Section met in a joint dinner meeting with the student branch of the University of Washington, in the Faculty Club on the University Campus. This is an annual affair when the students present 15-minute papers in a local contest, judged by three engineers from the Section. Prizes are presented for first, second, third, and fourth places, picked by the judges, by the Section. The two top winners then represent the branch in the paper contest at the Annual Pacific Northwest Student Conference. This year the conference is to be held at Oregon State College, Corvallis, Ore., in April. The local contest at this meeting resulted as follows:

First prize—three engineer's handbooks of winner's choice to Donald E. Anderson for his paper, "Power Plant of the Future for Light Airplanes." Second prize—two engineer's handbooks of winner's choice to Milan Neslin, whose topic was "Materials for Gas Turbines." Third prize—one engineer's handbook of winner's choice to Stanley L. Bryant for "Use of Rubber for Suspension." Fourth prize—a pocket slide rule to Richard E. Holt, whose contribution was "Controlled Distortion." All four contestants did excellent work in presenting their material.

Hans Ernst Speaks at West Virginia Section

"Stars Above and Below" was the subject at the meeting on Feb. 24 at the Daniel Boone Hotel, Charleston, W. Va., and the speaker, Hans Ernst, fellow A.S.M.E., research director, Cincinnati Milling Machine Company, Cincinnati, Ohio. Eighty members and guests were given a graphic conception of the universe around us by this well-known amateur astronomer. Some notion of the almost incomprehensible magnitudes involved was conveyed by the speaker's construction of imaginery scale models. Thus with a grain of sand representing a light-year, a stream of sand to the moon would represent perhaps the diameter of a galaxy. Well illustrated by slides, Mr. Ernst adapted the imaginations of his listeners to each new magnitude as he took them stepwise from solar system to universe.

On March 24 at the Daniel Boone Hotel, an audience of ninety heard a talk on "The Coal-Burning Gas Turbine," by C. F. Kottcamp, Locomotive Development Committee, Bituminous Coal Research, Inc.

Wilmington Sub-Section Hears Talk on Engineering Yarns

On March 19 in the Hob Tea Room, Wilmington, Del., A. E. Buchanan, Jr., assistant manager, technical division, rayon department, E. I. Du Pont de Nemours and Company, gave a talk on "Engineering Yarns." Mr. Buchanan predicted a higher degree of mechanization in process industries than is known today, and pointed out the technological progress which results from close collaboration on industrial problems of research engineers with chemists, physicists, and metallurgists.

Worcester Section's Textile Division Holds Meeting

A textile meeting was held on March 6 at the Worcester Polytechnic Institute, Worcester, Mass., at which Charles E. Crede, chief engineer, L. N. Barry Company, spoke on "Dampening of Mill Movement by the Fraham System."

On April 3 at the Worcester Polytechnic Institute, Worcester, Mass., Francis Dunigan, engineer, General Electric Company, gave a talk on "Electronic Applications" Mr. Dunigan's illustrated lecture on electronic application dealt more especially with motor controls and resistance welding. Two General Electric sound films were shown, the first, "Resistance Welding," and the second, "Clean Waters." Both were excellent. The following officers were elected at the business meeting: Carroll C. Tucker, chairman, Warrens Snow, vice-chairman, and Raymond N. Tolman, secretary.

Student Branches

Alabama Polytechnic Institute Branch

On March 10 a meeting was held in the Ramsey Engineering Building when a secret ballot for the Merit Award was held, and the member selected for his outstanding efforts for the betterment of the branch was William E. Smith. Date of the engineer's carnival was announced and plans made for the preparation of the A.S.M.E. concession for the carnival. W. E. Smith and Y. J. Elizondo gave interesting reports on the A.S.M.E. meeting in Birmingham in February.

A.S.M.E. STUDENT BRANCH AT THE UNIVERSITY OF ARKANSAS

University of Arizona Branch

On Feb. 12 in the Engineering Building the meeting was conducted by Douglas M. Kerr, president. Mr. Brown, representative to the Engineers' Council, told of the latest plans for Engineers' Day. The program featured a talk on problems and improvements on gasoline fuels for the Otto cycle engine by Mr. Faller of the Ethyl Oil Corporation. His talk was supplemented by graphs and figures which were projected on a screen and which he used to illustrate the points he discussed. Forty-two were present.

University of Arkansas Branch

The branch held three meetings in March, in room 310, Engineering Building. The first, on March 12, featured talks by the following: R. J. Burke on "The Baylin Engine;" J. F. Masters on "Fuel-Oil Burners;" and C. G. Bogard on "Curing Concrete." The meeting on March 19 consisted of a talk by H. R. Shinn on "Gryoscopic Aircraft Instruments," and one by H. L. Poe on "Air-Conditioning Controls." On March 26 talks were presented as follows: Bill Reitz, "Exhaust Silencers;" W. W. Gartside, "Heat-Treatment of Steel;" and Ersel Harrison "Cutting-Tool Material."

University of Cincinnati Branch

On March 20 a meeting was held in Student Union with 25 members present. It was decided that the branch would award the three top men of the sophomore class a year's free membership in A.S.M.E. Prof. R. L. Smith, on behalf of the A.S.M.E. Cincinnati Section, said a few words regarding the previous meeting at which Messrs. Zeidman, Friedlander, and Kemeny presented technical papers. Professor Smith presented R. Lippert with a handbook on behalf of the Section for his part in the program. A film was shown entitled "Broaching," with the help of the Cincinnati Milling Machine Company.

Clemson College Branch

On March 6, at the regular biweekly meeting, C. E. Webber and R. T. Harrison, student members, were the speakers. Mr. Webber discussed the construction of naval guns and Mr. Harrison gave a talk on radiant heating

E. S. CARLSON GREETS E. V. FLANDERS AT CORNELL UNIVERSITY STUDENT BRANCH MEETING

which was concluded with a discussion. Sixty were present.

Colorado A. & M. College Branch

A regular meeting was held on Feb. 17 in the Mechanical Engineering Building. The speaker was Donald Ryder, a senior member, who gave an interesting discussion on the precision manufacture of ball and roller bearings, illustrated with a liberal supply of bearing samples for demonstrations. Seventeen were present.

On March 3 two sound movie films were shown: the first "Springtime Machinery for Sugar Beet Culture;" the second, "Sugar Beet Harvesting Machines." Both films were produced and loaned by the Beet Sugar Development Foundation, whose main office is located in Fort Collins. Nineteen were in the audience.

University of Connecticut Branch

A banquet and business meeting on Feb. 20 at the Shell Chateau, Willimantic, Conn., climaxed the semester's activities. Officers for the semester ending June, 1947, were elected as follows: Harold Walter Wilson, chairman; Serafino Mario Decorso, vice-chairman; William Anastasion, treasurer; and Charles A. Clark, Jr., secretary. The membership has increased to 35, with many more students stating their intentions of becoming members. A survey is being made to determine methods of facilitating greater co-operation with the other engineering societies at the school, as well as to increase and intensify the activities of the A.S.M.E. student branch.

A.S.M.E. STUDENT BRANCH AT THE UNIVERSITY OF CONNECTICUT

Columbia University Branch Management Division

The Management Division held a supper meeting in John Jay Hall on March 21, at which Joseph Motycka, labor standards manager, Pratt and Whitney Aircraft Division, United Aircraft Division, East Hartford, Conn., spoke on "Time Study: The Tool of Management." Mr. Motycka discussed the nation's high standard of living brought about by industry, and to illustrate his point, he compared the United States statistically with the other important industrial nations. Quoting from the National Industrial Conference Board, Mr. Motycka made the point that production is the source of all purchasing power, and stated that "if increasing production per worker is the key to our better way of life and to the strength of our nation the responsibility for increasing production should be shared by the nation as a whole." He then described what he felt was the responsibility of the public, management, and labor.

Columbia University Branch Industrial Engineering Division

An open meeting was held on Feb. 27 in John Jay Hall. E. A. McNeice, director of quality control for Johnson and Johnson, was guest speaker. He gave an interesting résumé of the history of statistical quality control and discussed the connection of inspection procedure and statistical quality control, stressing the interdependence of the two. He then explained sampling methods—single, double, and sequential, illustrating with charts. Forty were present.

Cooper Union Institute of Technology Branch

The regular monthly meeting on March 10 was devoted to the presentation of two technical papers written by students. The first, "The Isothermal Manifold" was given by Howard Silfin, a sophomore, who introduced his paper with a discussion of the problems of carbonization in internal-combustion engines, illustrating with slides. Anthony Peranio, also a sophomore, gave the second paper entitled "Extracting Silver from Used Hypo Solutions," a rather important process in the economic operation of large-scale development of photographic film. Twenty-five were present.

Cornell University Branch

On Feb. 19 the first meeting of the spring term was held in West Sibley before an audience of 53 members and guests. E. V. Flanders, chief engineer, thread-grinding division, Jones and Lamson Machine Company, gave

an interesting talk on "Modern Developments in Thread Grinding." His subject was illustrated with excellent sound movies. The branch, with a new slate of officers, seems headed for a most successful season.

University of Florida Branch

A business meeting was held on March 6, at which the A.S.M.E. Student Conference to be held at Atlanta, Ga., was discussed.

On March 20 a meeting was held in the Engineering Building when a film entitled "This Amazing America" in technicolor, was enjoyed by an audience of 23.

Illinois Institute of Technology Branch

The first meeting of the spring semester was held on March 7 in the auditorium of the Student Union Building. A new membership drive was opened by Kurt K. Kuhnle, president, and S. E. Rusinoff, honorary member. Mr. McMahon of The Republic Flow Meters Company, gave a short talk on "Fluid Flow Measurement." One hundred and fifty members and 22 guests were present.

Iowa State College Branch

The program at the meeting on March 4th in the Engineering Assembly Hall, was a talk on "Stainless Steel," by David W. McDowell, Sr., mill contact metallurgist, Republic Steel Company, Chicago. The talk was illustrated with a sound movie. Seventy members and 20 guests were present.

University of Kansas Branch

The first meeting of the spring semester was held on Feb. 25 in Snow Hall with thirty-nine members present. Samuel M. Dean, head of the mechanical and architectural engineering department at Peking National Teachers College, Peking, China, gave a talk entitled "Engineering in China, Past and Future." Mr. Dean, a graduate of Penn State College, is also a missionary on the Presbyterian Board of Missions, and appeared at the University in conjunction with Religious Emphasis Week.

A.S.M.E. STUDENT BRANCH OF THE UNIVERSITY OF MARYLAND

He told of the growth from small engineering firms to present-day enterprising organizations unable to fill their orders, and stressed the unlimited opportunities available to young engineers in China in the near future.

University of Kentucky Branch

On Feb. 28 a meeting was held in the University high-school auditorium. C. E. Youngblood, chairman, urged members to write papers for the spring convention. T. R. Terry, honorary chairman, explained plans for preclassification for the next quarter in the mechanical department. An election was then held to select a girl from the mechanical engineering department to be a candidate for queen at the dance for engineers on March 29. Three girls were nominated: Marjorie Sulzer, Barbara Noland, and Billie Whitten. Barbara Noland was elected. One hundred and sixty-two were present.

Fifteen members with the honorary chairman, made an inspection trip on March 11 to a Kentucky utilities power plant being constructed on the banks of the Kentucky River at Tyrone, Ky. The main building was not yet fully constructed, and only a small part of the equipment was in place, but nevertheless, there was a good opportunity to observe a great deal about steam power-plant construction which could not be easily observed in a plant in operation.

Lafayette College Branch

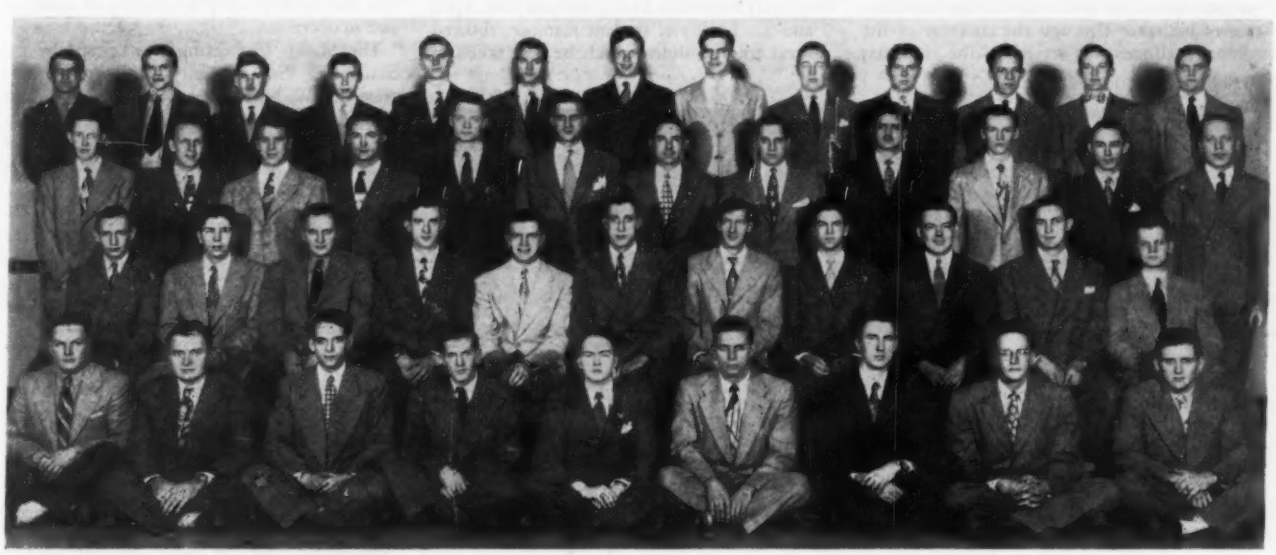
Together with other engineering societies of the college, a meeting was held on Feb. 20 in Markle Hall. It was the first meeting of its kind in college history, and the co-operation among the various societies was excellent. A color-sound film "Color Conditioning in Industry," was shown. Fifty-eight were present.

Marquette University Branch

On March 13 in the Engineering Building the first meeting of the spring quarter was called to order by George Elwers, president. Twenty-four new members were installed. President Elwers explained the benefits of the Society to the new men and emphasized the coming convention. Forty-five were present.

University of Maryland Branch

On Feb. 25 in the Engineering Building



A.S.M.E. STUDENT BRANCH AT THE UNIVERSITY OF MICHIGAN

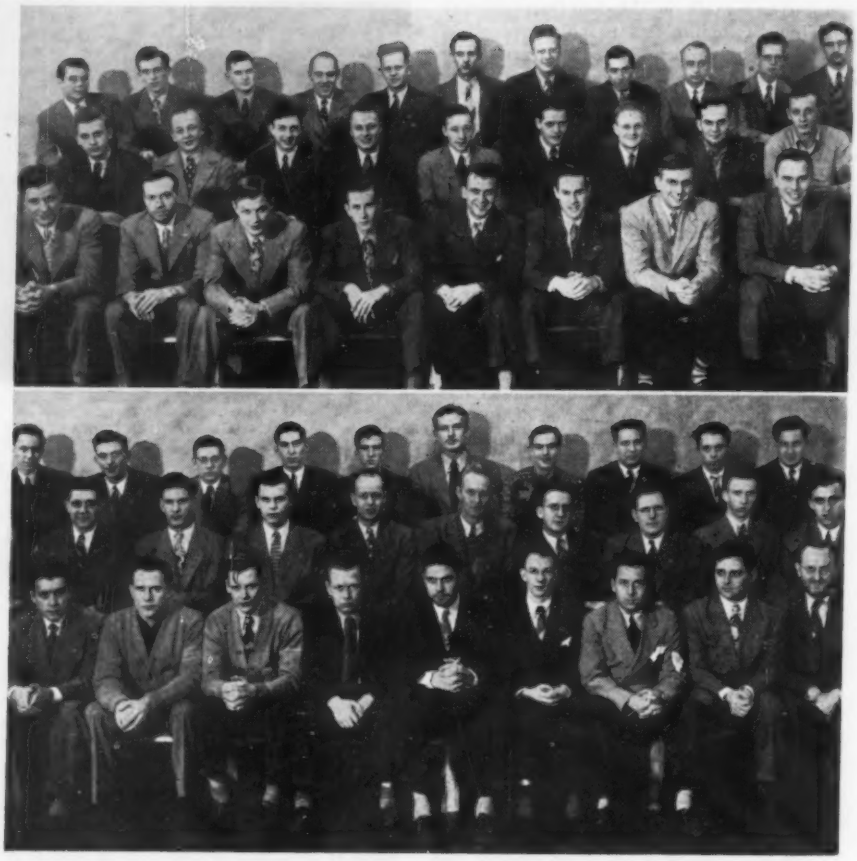
Rudolph Michel, member A.S.M.E., principal engineer for the U. S. Bureau of Ships, and past-chairman, A.S.M.E. Washington Section, gave a talk on the future of mechanical engineers. He told how new engineers have entered the engineering field with a feeling that most of the important engineering work had already been accomplished, and then how these same engineers have carried on in further development and invention until they suddenly realize that everything has not been discovered and that they have always had an unlimited future in engineering. He also spoke on torsional and linear vibrations in ships and in ship engines. Thirty members were present.

Michigan College of Mining and Technology Branch

A regular meeting of the branch was held at the campus clubhouse on Feb. 25. Election of officers was held and plans for the national meeting were discussed. A very entertaining talk was given by Prof. A. P. Young, member A.S.M.E., honorary chairman, on The National Metals Congress held at Atlanta, Ga.

University of Michigan Branch

A meeting was held on March 17 in the West Engineering Building, with 70 members and 8 guests present. Albert C. Pasini, member A.S.M.E., assistant superintendent of the Connors Creek plant, The Detroit Edison Company, gave a talk on "Power-Plant Engineering." He described, with the aid of slides, the general layout and functions of the steam power plant, and presented a comprehensive survey of what the power industry expects of the newly graduated engineer in such a plant.



A.S.M.E. STUDENT BRANCH OF THE MICHIGAN COLLEGE OF MINING AND TECHNOLOGY

University of Minnesota Branch

An inspection trip through the Wm. Bros Boiler and Manufacturing Company's plant, Minneapolis, Minn., on Feb. 19, took the place of the regular meeting. About 50 student members were shown through the plant, in groups, where they observed the various operations performed in the manufacture of boilers. Through the courtesy of the company, dinner was served to the students; and following dinner Mr. Bros spoke on the fundamentals of boiler design, and illustrated his talk with slides.

Mississippi State College Branch

On Feb. 26 Professor Staton, honorary chairman, explained the purpose of the A.S.M.E. Regional Convention held in Atlanta, Ga., April 7 and 8. J. Hoyle, student member, showed several colored slides which he had taken of Gulfport, Miss. and New Orleans, La., and several engineering structures of interest in these cities. Professor Staton gave a short talk on the "Marvoir" heating and air-conditioning unit. Magazines with illustrations and diagrams of the unit were shown to the members. He then took the students into the machine shop to observe an installed unit in operation.

The March 26 meeting was opened by the chairman, Fred O'Kelly. Nineteen were present. W. N. Mingee was named chairman of a committee selected to contact Mr. Holmes, the head of the mechanical engineering department, in order to set up an organized system for contacting possible employers of the Southeastern area, as to their need for graduating seniors, and to have a representative of their firms give interviews for these graduating students. George Ramsey, a student member, gave an interesting talk on miniature gasoline airplane engines.

A.S.M.E. STUDENT BRANCH OF THE UNIVERSITY OF NEVADA WATCHES DIESEL ENGINE DEMONSTRATION

Missouri School of Mines Branch

On March 6 students and faculty members totaling 400, packed the auditorium of Parker Hall, the largest auditorium on the campus, to see a technicolor motion picture on the design and development of the Navy's carrier-based, jet-propelled plane, the Phantom, and to hear a talk by William L. Blatz, project aerodynamist for the McDonnell Aircraft Corporation, St. Louis, Mo., on "Trends in High-Speed Aircraft Design," which dealt with the

developments in aircraft design during the war and the current aerodynamic problems of the trans-sonic speed region. This meeting climaxed the spring membership drive of the branch, which boosted the rolls over the 100 mark.

C. L. Fay, assistant to the vice-president of engineering, Bell Aircraft Corporation, was guest speaker at the March 19 meeting of the branch. Mr. Fay spoke on jet propulsion, and presented two technicolor motion pictures, "Report on Jet Propulsion," and "The Modern Magic Carpet," the latter film dealing with the Bell helicopter. There was a lively question-and-answer period following the talk. Approximately 200 members and guests were in the audience.

University of Nebraska Branch

A meeting was held on March 19 in Richards laboratory with 32 present. Plans were discussed for a ball and banquet in connection with Engineers' Week activities. The program consisted of the showing of a General Electric movie on resistance welding, and a March-of-Time film on "Atomic Power."

University of Nevada Branch

The branch sponsored a meeting of the associated engineers of the University on Feb. 19. J. W. Anderson, member A.S.M.E., executive engineer of the Atlas Imperial Diesel Engine Company, Oakland, Calif., presented an illustrated lecture on the history and development of the Diesel engine. A general discussion period followed.

A short business meeting was held on March 5. A general discussion of the aims and purposes of the branch was led by the new chairman, Douglas Bevans, for the benefit of the new mechanical-engineering students. A new program and publicity committee were selected to direct meetings for the rest of the spring semester.

Newark College of Engineering Branch

At the March 17 meeting in room 30A, Paul Livera, former chairman, was nominated and unanimously chosen as the member who had done most for the branch during the last semester. The speaker was Otto de Lorenzi, member A.S.M.E., director of education, Combustion Engineering Company, Inc., New York, N. Y., who gave a talk on "Stoker Fuel Beds." The operation of the four types of stokers, single-retort, multiple-retort, traveling-grate, and the spreader stoker, were explained by the use of slides, and color movies of furnaces showed the movements of fuel beds. Mr. de Lorenzi said that color movies have become a tool of the combustion engineer and explained that it is possible to put in much work on a few hundred feet of film. The goal of combustion engineers, he explained, is to be able to use all kinds of fuels efficiently in stokers. Fifty were present.

College of the City of New York Branch

On March 6 in the Main Building, J. Markowitz, a faculty member, gave a talk on the subject of vibrations. He showed the development of vibration formulas, and emphasized that equations based on rotary motion could be used to describe all types of vibration. Eighty-six were in the audience.

At the regular meeting on March 13 in the Technology Building, the speaker was Professor Smith of the mechanical-engineering department. His talk concerned the New York State Professional Engineer's Examination. Jerome Mandel, president, announced that a meeting on this topic will be held once each term hereafter.

A joint meeting was held on March 20 with the S.A.E. branch. Merrill C. Horine, a Mack Truck official, spoke on "The Engineering Process." Mr. Horine accused engineers of using technical jargon to mystify the layman, and of writing reports that are dull and hard to read.

On April 4 in Compton Hall, the members voted to send a telegram to Congress in support of the Rogers bill, which would increase the subsistence for veterans studying under the G.I. law. A talk on "Copper and Its Alloys" was given by Ira T. Hook of the American Brass Company. Mr. Hook first discussed the nation's future copper supply, saying that the known copper deposits may last only another generation, but expressing confidence that there are large undiscovered ones. He displayed samples of various copper alloys and told of their uses. Fifty-seven were present.

A.S.M.E. STUDENT BRANCH OF THE COLLEGE OF THE CITY OF NEW YORK

New York University (Day School) Branch

On April 1 the members heard fine speeches by Mr. Allen and Mr. Anderson of the Republic Flow Meters Company, on "Automatic Controls." Their lectures were accompanied by some very fine slides on the subject. Fifty-two were present.

New York University (Evening School) Branch

On Feb. 25 a meeting was held in the Waverly Building. The program consisted of a Kearney and Trecker film, "The Rotary-Head Milling Machine." August J. Kwossek, who is in the milling department of the Sperry Gyroscope Company, gave a running commentary on the film, describing the various parts, functions, and operations being shown. Thirty-one were present.

North Carolina State College Branch

On March 13 in the Administration Building, 117 heard Leo A. Ohlinger, consultant on nuclear energy for propulsion of aircraft at the Northrop Aviation Plant, give an address on "The Future of Atomic Energy."

The meeting on April 1 in Page Hall, was called to order by the newly elected president, A. W. Futrell, Jr. New officers for the 1947-1948 school year were installed, as follows: Robert T. Lloyd, Jr., vice-president; J. B. Alexander, recording secretary; J. N. Seid, corresponding secretary; T. B. Carpenter, treasurer; and F. D. Masten, historian. Thirty-nine were present.

North Dakota Agricultural College Branch

On March 12, 20 members and several guests assembled in room 204, Engineering Building, to hear J. W. Hoffman of the Northern States Power Company, speak on the cost of manufacturing power and heat. Mr. Hoffman, a graduate of the University of Minnesota, and for the past 15 years associated with the Northern States Power Company, discussed the difference in cost of operation by use of water, steam, Diesel, and gas power, explaining when each should be used and the reasons for the variation in the cost of each at different times.

University of North Dakota Branch

A regular meeting was held on Feb. 25 in Chandler Hall. Two talks were given by student members: the first, by Raymond Lynch on the Hamilton watch and the functioning of engineering in regard to the success of this instrument; the second, by Patrick O'Connel, on the manufacture of potato flour.

Northeastern University Branch

At the meeting on March 5 in Richards Hall, Mr. Robinson of the engineering department of the University, gave a talk on "Stress Analysis Through Polarized Light." The slides which illustrated the talk depicted various stress analyses of different shaped specimens. Mr. Robinson also had a polarized-light apparatus setup and a demonstration was given. Fifty-one were present.

Northwestern University Branch

A business meeting was held on Feb. 1 in the Technological Institute. Charles Thorney was elected to replace Milton Nielsen as treasurer. Robert Gerhardt, vice-chairman and program-committee chairman, told of plans for the immediate future.

On March 7, F. A. Faville of the Faville-LeVally Corporation, spoke on "Citizenship Education." Mr. Faville said that the newly graduated engineer, in his anxiety to make a success of his career and prepare a proper start in life for his family, too often loses sight of his civic responsibilities. He stressed the value of taking an active interest in local government, and in furthering education to increase the general public interest which is lacking to a considerable extent, as indicated by frequent poor turnouts at the polls. Mr. Faville had several leaflets on the subject which he distributed to the members at the close of his talk. Thirty-three were present.

Oklahoma A. & M. College Branch

A meeting was held on Feb. 24 in room 302, Engineering Building. Prof. H. G. Thuesen, member A.S.M.E., head of the industrial engineering department, gave a talk entitled "Time and Motion Study." Following the talk an Allis-Chalmers film on gas turbines, "Tornado in a Box," was shown. There were 22 present.

"The Price of Engineers" was the topic of the March 10 meeting, discussed by Dr. Blair of the economics department. He talked of the economic situation in the world today as related to the salary possibilities of the young engineer.

University of Pittsburgh Branch

On March 20 at the Cathedral of Learning, James E. Knarr, personnel manager, Columbia Steel and Shafting Company, addressed the junior and senior members of the branch on "Human Elements of Engineering." Mr. Knarr told the students what the personnel manager expects of a prospective applicant, and the relationship between employer and employee. One hundred and twenty-five were in the audience, and enjoyed and appreciated Mr. Knarr's straightforward address so much that they invited him to return and again talk to them on April 3.

Polytechnic Institute of Brooklyn (Day) Branch

The subject of copper and how it is mined was the feature of a joint meeting with the A.I.M.E. on March 4th, at which Ira Hook, research engineer for the American Brass Company, was the speaker. Mr. Hook pointed out that the wide adaptation of copper for use as a thermal and electrical conductor has been made possible only through mass-production mining and the use of the flotation method of refining copper ore. A technical moving picture followed Mr. Hook's talk which gave an idea of the size of the world's largest copper mine at Chuquicamata, Chile. Ninety were present.

Princeton University Branch

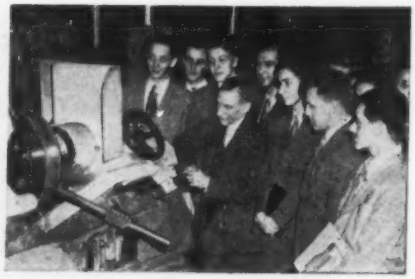
A meeting was held on March 6 at the Engineering Lounge, Engineering School, with 31 present. The program featured two films: the first, by the Norfolk and Western, entitled "The Modern Steam Locomotive;" and the second by United Air Lines entitled "Of Men and Wings." A new member, William Zabriskie, joined the branch.

On March 7 a party of 29 members made a trip to the De Laval Steam Turbine Company's plant. Guides explained the processes in capable fashion.

Queen's University Branch

On March 13 the final-year members of the branch visited the Kingston Works of the Canadian Locomotive Company. The students were shown the successive stages of construction of the modern steam locomotive, and the special equipment necessary for such construction. Points of interest were the pressing of drive wheels on the axles, the boiler construction, forge shop, machine shop, assembly shop, and the factory power plant.

On March 26 elections were held for the positions of chairman and secretary for 1947–1948, resulting in Walter Sutherland's election as chairman, and John Smythe as secretary.



UNIVERSITY OF PENNSYLVANIA STUDENT BRANCH VISITS S.K.F. INDUSTRIES, INC.

Rensselaer Polytechnic Institute Branch

On March 13 in room 13, Russell Sage Building, Sidney Low was guest speaker. Mr. Low is associated with the research division of the Chatman Valve Company, Indian Orchard, Mass., and is a graduate of the mechanical-engineering department of the Institute, class of 1941.

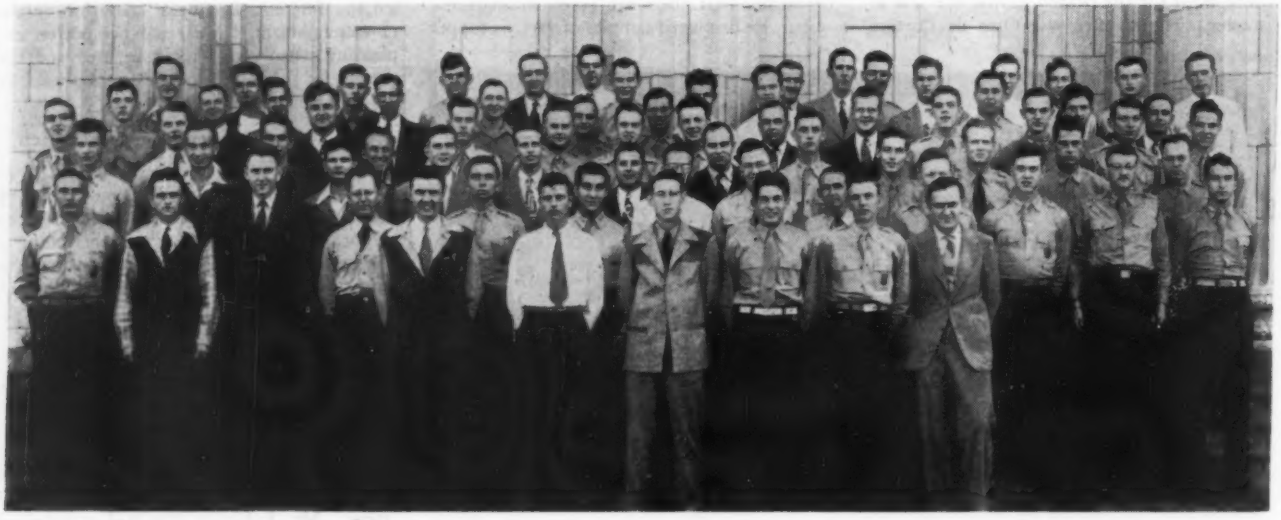
On March 27 Dr. Crew, dean of students, gave an address on "More Efficient Methods of Wrecking Trains." During the recent war, Dr. Crew worked with the National Defense Research Council. He accompanied his talk with a motion picture, taken by himself, showing the effects of the tactics followed.

University of Rochester Branch

A meeting was held on March 6 in the Engineering Building with 26 present. Prof. R. J. Raudebaugh gave a talk on "Stress Coat," followed by several demonstrations of the process.

South Dakota State College Branch

A joint meeting of the branch with the A.I.E.E. and A.S.C.E. was held on March 5 in the Classroom Annex, attended by an audience of 105, including students and instructors.



HERE ARE 73 OF THE 300 MEMBERS OF THE TEXAS A.& M. COLLEGE STUDENT BRANCH

At the business meeting Robert Nelsen, general chairman of the Engineers' Spring Banquet, reported on the progress of this event. Ten-minute talks were given by two students: Charles Wondra spoke on a shipyard layout and Marvin Mills talked on the electronic calculator at M.I.T.

Syracuse University Branch

On March 19 a meeting was held with the members of the Syracuse Section in the Syracuse Museum of Fine Arts. A dinner preceded the meeting. For the program, three students presented the problems of the novice engineer. Robert Carson discussed the problems of the engineering student and emphasized that the student is handicapped by too little knowledge of what the field of engineering really encompasses. George Hammond presented a talk on the profession as seen through the eyes of a returned serviceman. After a few simple computations, Mr. Hammond pointed out how, after studying, eating, working, and sleeping, the average student-veteran who is married is minus ten hours every week. Miss June Kath defended the place of women in the engineering field, illustrating by several examples the present climate of opinion toward the professional woman. Twenty student members and 12 senior members were present.

University of Tennessee Branch

At the Feb. 6 meeting in Estabrook Hall plans were made to try to induce more student engineers to attend meetings and take a part in the student organization. The program consisted of a movie on navigation aids in flying. Prof. R. W. Morton, member A.S.M.E., head, mechanical engineering department, conducted the discussion of the movie. Twenty were present.

On March 6 Chairman Mayberry called the meeting to order with 18 members present. The speaker of the evening was Mr. Sweeney, instructor on the mechanical-engineering staff of the University. He gave an excellent talk on the methods of production used by the Rohm Haas Company in making plexiglas for the war effort.

A joint meeting was held on March 11 with the A.I.Ch.E. A film was shown which was loaned to the University by Allis-Chalmers Company, entitled "Tornado in a Box." Thirty-seven students and teachers attended.

Texas A. & M. College Branch

On Feb. 4 the branch met in the mechanical-engineering lecture room. Jim Fix was elected vice-chairman, to fill the place of the graduating vice-chairman. H. R. Pearson, member A.S.M.E., of the Dallas Power and Light Company, spoke on "The Engineer and Personnel Administration."

The meeting on Feb. 18 was held before an audience of 200. W. J. Graff was appointed representative of the branch to the Cotton Pageant and was asked to pick four members to act as his assistants. A talk was given by Prof. Carl Files, junior member A.S.M.E., honorary chairman, entitled "Gas Turbines and Jet Engines."

On March 4 a meeting was held in the lecture room of Fermier Hall with 200 members and 50 guests present. J. C. Klien, research engineer of the Texas Foundries Inc., Lufkin, Texas, gave a talk on the history of malleable castings, and methods employed by his company, and the properties of malleable iron. Questions were asked at the close of the talk. Mr. Sayers, personnel manager of the Texas Foundries, Inc., gave an impromptu discussion pertaining to personnel selection.

A.S.M.E. STUDENT BRANCH OF TUFTS COLLEGE

University of Texas Branch

On March 3 in the Engineering Building, Stan E. Keunstler, president, called the meeting to order with 45 present. As a climax to the program-idea contest, five dollars was awarded to Member Herndon for his plan to inspect interesting places on the campus where activity of an engineering nature is in progress. The speaker was Mr. Hazel of the Oil Well Supply Company, who gave an interesting talk on problems concerning drilling and operation of oil wells. Three movie reels were shown: "Oil Well Sucker Rods;" "Oil Well Pumps;" and "Steel."

Three speakers entered the "run-off" contest at the March 31 meeting in the Engineering Building. Nelson Hickok gave a talk on "The Propeller Pitch Indicator;" Bob Marshall a talk on "The Heat Pump;" and Clay Price a talk on "Hydraulic Couplings and Torque Converters." All members present graded the speakers and Nelson Hickok and Bob Marshall were selected to participate in the regional meetings of the A.S.M.E. at Houston, Texas, on April 12, and at Norman, Okla., on April 28 and 29. Calvin Porcher, Joe Noble, and Jack Roberts were appointed to the committee to make plans for A.S.M.E. participation in the Power Show. Thirty-nine were present.

Tufts College Branch

On March 6 a plant trip was taken to the Mystic Power Station of the Boston Edison Company. Thirty-six senior mechanical engineers saw the layout and operation of a modern power plant from the pulverizing of coal to the control and dispatch of the electrical power. The Mystic Station, which is operating at 1200 psi, using both oil and coal, is one of the most efficient and economical power plants in the country.

The guest speaker at the March 18 meeting in Robinson Hall, was Clayton B. Rock, General Electric Company. Mr. Rock, who has been doing industrial-relations work for the past ten years, spoke on the development of the unions as viewed by his concern from the time of their first introduction into a General Electric plant in 1931 up to the present time. The question period that followed led to a general discussion on the Wagner Act, closed shop, wage incentive, and employee profit-participating policies and their effect upon industrial relations. Sixty-two were present.

On March 27 four papers were given by students. The first by W. Collier was entitled "Corrosion: A Design Problem;" the second by A. Simonowitz, on "The Art of Thinking;" the third by J. S. Kloss on "The Wagner Act—and Management;" and the fourth by M. W. Goodwin on "Wing Designs for Greater Lifting Power." Thirty-five were in the audience.

Vanderbilt University Branch

A smoker was held on Feb 12 at which W. C. Armistead spoke on the attitude of the student in school and after leaving it. His talk was very instructive and applicable to anyone in any field. Two films, "Futurama" and "To New Horizons," were shown. On Feb. 20 a showing of the film, "Tornado ina Box," was the feature, and at the Feb. 27 meeting Prof. J. E. Boynton, member A.S.M.E., director, department of engineering, told the members about the A.S.M.E. student conventions of the past.

Villanova College Branch

A meeting was held on Feb. 28, attended by 31. The new chairman, Brad Johnson, opened the meeting, and introduced the guest speaker, J. Stanley Morehouse, member A.S.M.E., dean of engineering at Villanova College. Professor Morehouse gave a talk on the value of writing and presenting papers at A.S.M.E. meetings.

Virginia Polytechnic Institute Branch

At the Feb. 24 meeting two films were shown: "The Power House of Aviation,"

produced by the Wright Aeronautical Corporation; and "Carbon Electrodes" produced by the National Carbon Company.

On Mar. 3 a meeting was held in Patton Hall auditorium, and attended by 109 members and visitors. C. E. Pond, member A.S.M.E., assistant superintendent of motive power, Norfolk and Western Railway, Roanoke, Va., vice-chairman of the Virginia Section A.S.M.E., member of the National Railroad Committee, A.S.M.E., gave an interesting talk on several of the types of coal-burning steam locomotives currently in use by the Norfolk and Western Railway.

A film was shown entitled "The Modern Coal-Burning Steam Locomotive," which is a story built around the Class "J" locomotive. R. L. Graham of the American Blower Company, Detroit, Mich., followed, with a showing of slides of the various types of hydraulic coupling or fluid drive manufactured by his company, and discussed several applications of the hydraulic coupling in the State of Virginia, with data as to the general economy and operational characteristics of such units. Several members of the faculty were among those present.

University of Virginia Branch

An open meeting was held on Feb. 27 in Thornton Hall, at which time Brig. Gen. Frank O. Bowman of the Army General Staff, addressed the audience on "The Differences Between Military and Civilian Engineering Practices," explaining the Army's viewpoint of subjects of common interest to all engineers. Edward Heath, president of the branch, announced that a trip to the Aeronautical Laboratory at Langley Field will be made early this spring.

West Virginia University Branch

On March 3 the following officers were elected for the second semester: A. L. Clark, president; M. L. Hoover, vice-president; J. M. Brown, secretary; W. A. Watson, treasurer; and L. M. Coughlin, sergeant at arms. The program which followed the business meeting was given before the General Engineering Society which is composed of the membership of student branches of the Founders' Societies. Eugene D. Benton, assistant supervisor of the Fuels Division, Battelle Memorial Institute, Columbus, Ohio, gave a talk, illustrated with slides, on "The Use of Steam-Air Jets in Locomotive Smoke Abatement."

Yale University Branch

On March 6 in Dunham Laboratory the following officers were elected to positions on the Conference Committee: S. B. Girdler, chairman, Registration Committee; Fred Chellis, chairman, Inspection Committee; Edmund B. Swort, chairman, Accommodations Committee; and F. J. Zimmerman, chairman, Arrangements Committee. Three student papers were presented. The first by Dave Vaughn was entitled "Detonation in Internal Combustion Engines." The second by Ed Swort was "The Production of Air Frames; and the third by Aidan Stone, "Education in Industry." Fifteen members and two guests were present.

A.S.M.E. Sections

Coming Meetings

Baltimore: May 26. Engineers Club at 8:00 p.m. Subject: "Steam Turbines," by E. E. Parker, assistant designing turbine engineer, General Electric Company, Schenectady, N. Y.

Birmingham: May 23. Tutwiler Hotel, Birmingham, Ala. at 6:30 p.m. Eugene W. O'Brien, president, A.S.M.E., will speak to the members and guests on a timely subject.

Cincinnati: Wyoming (Ohio) Golf Club. Annual meeting and national president's night. Dinner 6:30 p.m. Meeting 8:00. President O'Brien to speak.

Fairfield County: May 23. Hotel Barnum, Bridgeport, Conn. at 7:00 p.m. Annual Ladies' Night Meeting. Speaker: A. A. Nicholson, The Texas Company, New York, N. Y.

Metropolitan: May 14. Junior Group Meeting. Room 502, Engineering Societies Building, New York, N. Y. at 7:30 p.m. A forum on "Presentation of Plan for Professional Development."

Schenectady: May 22. Place to be announced. Subject: "Gas Turbines," by Alan Howard, turbine generator engineering division, General Electric Company, Schenectady, N. Y.

Southern Tier:[1] May 26. Arlington Hotel, Binghamton, N. Y., at 6:30 p.m. Subject: "Properties of Luminescent Materials," by L. T. Weagle, R. C. A. Victor Division, Lancaster, Pa.

South Texas: May 1 and 2. Rice Hotel, Houston, Texas. 8:00 p.m. on May 1; 10:00 a.m. and 2:00 p.m. on May 2. Subject: Revisions of Boiler Code to be discussed with A.S.M.E. Boiler Code Committee.

[1] Name changed from Ithaca Section.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. All replies should be addressed to the key numbers indicated and mailed to the New York office. When making application for a position, include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3.50 per quarter or $12 per annum, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	211 West Wacker Drive	109 Farnsworth Ave.	57 Post Street

MEN AVAILABLE[1]

MECHANICAL ENGINEER, with distinct executive abilities. Can handle design, men, and factory work. Especially suited to position where sound training in many fields of engineering and business is needed. Me-168.

GRADUATE MECHANICAL ENGINEER, age 31, ten years' experimental, research, design, development work in fluid-flow, thermal, and automatic-control devices. Desires similar work with consultant or manufacturer in Chicago area. Me-169.

MECHANICAL GRADUATE, June, 1947, age 25, married, World War II veteran, would like start in business operations or engineering planning. Prefer location around New York, N. Y. Wages no objective. Me-170.

POWER PLANT ENGINEER, experienced in over-all supervision of modern central-station steam plants. Nineteen years' operation, maintenance, and general progressive administration, and technical training, age 45 Me-171.

SALES ENGINEER, 28, single, B.S. degree, former naval officer. Four years' chief engineer Diesel-powered ships. Last 1½ years in selling, engineering, servicing technical products in heavy industries. Excellent engineering and commercial experience plus contacts. Wants engineering sales with machinery manufacturer where engineering knowledge essential. Preferred location, New York, N. Y., area. Me-172.

ENGINEER—DESIGNER, 35, married. Experienced, machine-tool and product design, plant layout and processing. Fifteen years with jobbers and consulting-engineering firms. Supervisory experience. Desires permanent position. Me-173.

DEVELOPMENT ENGINEER. Successful record in the distinctive design and development of small parts, mechanisms; supervise draftsmen; order parts; contact suppliers. Eastern location preferred. Me-174.

MECHANICAL ENGINEER, graduate, age 25. Four years' experience in design and research

[1] All men listed hold some form of A.S.M.E membership.

work. Desires a position with small aggressive development or research firm. North Jersey preferred. Me-175.

MECHANICAL ENGINEER, graduate, age 46. Experience: 12 years' industrial-plant erection, and maintenance and ship repairs; 5 years shop superintendent (foundry, structural, and machine shops); 5 years marine design engineer (present position) main engines, auxiliaries, piping, ventilation, and refrigeration in conversion work. Desires permanent supervisory position in similar lines of work. Me-176.

MECHANICAL ENGINEER, 28, family, 4 years in marine Diesel operation and maintenance; one year marine steam operation and maintenance; one year aircraft-production experience; 18 months developmental testing gas-turbine power plants. Desires sales or service in petroleum or other fields where experience can be utilized. Me-177.

POSITIONS AVAILABLE

ENGINEERS: (*a*) Mechanical engineers with pulp- and paper-mill experience, both in design and operation. (*b*) mechanical engineers with general experience in power-plant design, heating, ventilating, and air conditioning, to design and execute working drawings. W-8757.

ENGINEER, with considerable woodworking experience for good-sized industrial organization making textile machinery. Maine. W-8762.

ENGINEERS: (*a*) Chief engineer, 35–50, mechanical-design engineer, with some knowledge of wood technology, wood laminates, wood chemistry, and civil engineering or interested in above. Salary, $5000–$6000 year plus bonus. (*b*) assistant to chief engineer, 28–40, with forestry background, preferably having majored in wood technology and having had some experience with wood laminates or having working knowledge of chemical engineering and steam. $3000–$4500 plus bonus. Tennessee. W-8764.

WOODWORKING ENGINEERS, experienced, mechanical graduate or equivalent, with knowledge of kiln drying, woodworking machines, cabinet work and finishing. Must be able to instruct setting-up machines, saw filing, and knife grinding; have experience in time and motion study and installation of wage-incentive systems; have ability to instruct workmen and design new machine attachments, jigs, fixtures and forms, and knowledge of drafting for layout work. Tennessee. W-8765.

MECHANICAL ENGINEER, thoroughly experienced in plumbing, heating, ventilating, air conditioning and process pipe work. $4500–$5000. Some traveling. Upstate New York. W-8784 (*b*).

ENGINEERS, mechanical and electrical, for supervision of operation and maintenance of steam-electric and Diesel-electric utility power plants. Should have mechanical and some electrical experience and preferably some utility-plant experience. Operators of generating plants for industries will be considered. Some knowledge of Portuguese desirable. Write giving experience and salary earned in each position. Salary open. Brazil. W-8786.

PLANNING SUPERVISOR, 35–40, preferably graduate industrial engineer, who has had experience in and is capable of doing the planning and scheduling for growing manufacturer. Should be experienced in materials flow, scheduling, etc. Salary open. Connecticut. W-8799.

CHIEF ENGINEER to take charge of and be responsible for operation of boilers, steam engines, ammonia compressors, air compressors, d-c generators and over-all general maintenance of all mechanical devices and equipment, piping, in brewery and beverage plant. Pennsylvania. W-8804.

CHIEF ENGINEER, engineering graduate, to be responsible for product design, methods, tooling, and inspection for a progressive steel-office-furniture company. $6000–$8000. Pennsylvania. W-8841.

GENERAL MANAGER OF CONSTRUCTION, 30–40, mechanical graduate, with open-hearth or process-furnace design and construction experience, to take general charge of construction program. $12,000–$15,000. East. W-8849.

ENGINEER, young, graduate, with one or two years' practical plant-operation experience, to work in a food-products plant. Must be able to get along with executives. Upstate New York. W-8855.

ENGINEER, to act as assistant to export manager, 25–35, preferably graduate engineer or one who has had the equivalent in contact with machinery plus some business experience in export or abroad. Must speak fluent Spanish. Must be willing to travel. $5000–$7000 year. New York, N. Y. W-8856.

RECENT GRADUATE ENGINEERS, mechanical or chemical engineering graduates, preferably the former, not over 27, single, for service in the Far East. Positions will be terminal-operating assistants in the storing, packaging, and distribution of petroleum products. Starting salary, while in training in this country, $3000; upon assignment abroad, $3900, plus living allowances. Period of assignment, three to four years, depending upon territory to which assigned. Interviews, New York, N. Y. W-8869.

ENGINEERS: (*a*) Assistant chief engineer, 40–50, mechanical graduate, with petroleum or coal-tar chemical-plant design experience, to take charge of mechanical design, specification and construction of new plant. $10,000–$12,000. (*b*) Designer, 30–50, mechanical or chemical graduate, with high-pressure design experience as applied to chemical industry, to do vessel design for development of high-pressure techniques and general plant-equipment design. $6000–$8000. Eastern Pennsylvania. W-8895.

MECHANICAL ENGINEER, graduate, with broad experience, to supervise and direct two projects; one project concerns expansion of brewery facilities with particular reference to increased steam- and electric-power capacity; other project would involve consultation and supervision in connection with additional power-plant capacity for a steel mill. Should have knowledge of Mexican and Spanish. Write giving full details of background, references, salary desired, and personal data. Mexico. W-8898.

SALES MANAGER, with some experience in sales through dealers and distributors, preferably located in the Middle West. Some contact with architects and contractor desirable. Elevator- and heavy-machinery experience helpful. $6000. Ohio. W-8903.

APPLICATION ENGINEER, 30–40, mechanical graduate with process-equipment design and application experience, to design stainless steel, nickel, nickel-clad steel tanks, and pressure vessels. Must know welding techniques and have ability and personality to contact chemical concerns. $5000–$6000 year. Chicago, Ill. W-8911.

ENGINEERS. (*a*) Transportation analyst, 30–35, graduate, with transportation and traffic experience in trucking field and knowledge of rates, costs, shipping, and warehousing problems, for industrial organization. $4500–$5400. (*b*) Educational supervisor, 30–40, college graduate, with teaching or supervisory experience in industrial field, to assist in planning and executing training programs of "management" personnel. $4800. Ohio. W-8917.

INSTRUCTORS, of various ranks for rapidly developing school of engineering. Men with advanced degrees, teaching, or professional experience desired. Openings in civil, mechanical, and electrical engineering. Massachusetts. W-8923.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after April 25, 1947, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Fellow, Member, Associate, or Junior

AINSWORTH, FREEDOM H., Detroit, Mich.
ANDREWS, B. M., Atlanta, Ga.
ARNOLD, H. R., Savannah, Ga.
BARBER, EVERETT M., Wappinger Falls, N. Y.
BARRAJA-FRAUENFELDER, J., New Rochelle, N. Y. (Rt)
BONE, G. W., Frinton-on-Sea, Essex, England.
BRITTON, ERNEST W., Yonkers, N. Y.
BROWN, GEORGE CHARLES, Dayton, Ohio
BUTRIM, JOHN J., Rochester, N. Y.

CAGNO, L. A., Chicago, Ill.
CAKE, WALTER J., Upper Montclair, N. J.
CANNON, CHARLES J., JR., Birmingham, Mich.
CASSELMAN, DANIEL R., Baytown, Texas
CHAMBERLAIN, ROBERT E., Dunellen, N. J.
CHAMBLESS, LOUIS S., Chattanooga, Tenn.
COON, WILBERT EARL, Baltimore, Md.
COWAN, KENNETH R., River Forest, Ill.
CRAWFORD, WILLIAM E., Milwaukee, Wis.
DAVE, N. M., Bombay, India
DEMERIT, EUGENE G., Schenectady, N. Y.
DESCHERE, ALLEN R., Boulder, Colo.
DIEHL, WARD F., Detroit, Mich.
DILDINE, DEAN M., Lakewood, Ohio
DORMAN, ALBERT A., Philadelphia, Pa.
DUBOFF, JACK IRVING, Peoria, Ill. (Re)
DUCHEMIN, NICHOLAS M., West Lynn, Mass.
EDDINS, JOHN B., Chicago, Ill.
ERIKSON, CARL F., New York, N. Y.
EVANS, ARTHUR K., Fanwood, N. J.
FARRAR, GLENN D., Atlanta, Ga.
FAWCETT, JAMES FLETCHER, Belle, W. Va.
FINLEY, JACK D., Tulsa, Okla.
FISHER, LYMAN C., Silver Spring, Md.
FLINK, H. G., Wilmington, Del.
FORBES, E. L., Fordtown, Tenn.
FRAWLEY, VINCENT A., St. Paul, Minn.
GAGNE, JOSEPH E., Bloomfield, N. J.
GARMAN, GEORGE G., Washington, D. C.
GAYNOR, PETER F., JR., New Rochelle, N. Y. (Rt & T)
GILLIS, ALPHONSE P., Chicago, Ill.
GRAY, W. G., Chicago, Ill.
GREEN, DOUGLAS A., Los Angeles, Calif.
GRIST, ALPHEUS C., Chattanooga, Tenn.
GROUNDWATER, W. H., Los Angeles, Calif. (Rt & T)
HAAS, D. MARSHALL, Baytown, Texas (Rt & T)
HALE, WILLIAM F., Merrick, N. Y.
HARDER, EARL L., Tulsa, Okla.
HAWTHORN, HUBERT, Savannah, Ga.
HAWTHORNE, NATHANIEL F., Linden, Calif.
HEALY, GRANT S., Chicopee, Mass.
HENDERSON, G. R., Sarnia, Ontario, Can.
HOLMES, PAUL M., Columbus, Ohio
ILLINGWORTH, R. H., Dallas, Texas
IRONS, JEFFERY D., Tulsa, Okla.
JACKSON, JOHN T., New York, N. Y.
JOHNS, H. A., Houston, Texas
JOHNSON, MARTIN H., Relay, Md.
JOSEPH, A. F., Baroda, India
KENNEDY, JOHN J., Savannah, Ga.
KHANDKE, R. S., New York, N. Y.
KITZMAN, EMIL, Philadelphia, Pa.
KLEIN, PHILIP, Bridgeport, Conn.
KURDEKA, PETER LAURENCE, Brooklyn, N. Y.
LABRECQUE, T. A., Elmira, N. Y.
LALIKOS, JAMES, Detroit, Mich.
LANDER, LAWRENCE CHARLES, JR., Flint, Mich. (Rt & T)
LAWSON, HARRY MITCHELL, Baltimore, Md.
LODER, THOMAS RUDD, JR., Chattanooga, Tenn.
LOUGHIN, P. R., Westfield, N. J.
LOW, JAMES NORTON, Evanston, Ill.
LYNAH, J. H., Savannah, Ga.
MACGREGOR, CHARLES A., Cleveland, Ohio
MAC-VEIGH, JAMES JOHN, New York, N. Y.
MANSA, J. L., Charlottenlund, Denmark (Rt & T)
MARKAKIS, JAMES N., Baltimore, Md.
MARKS, DAVID, Detroit, Mich.
MARTIN, MILTON, Washington, D. C.
MARTIN, ROBERT H., West Collingswood, N. J.
MAXWELL, MARVIN V., Chicago, Ill.
MILLER, RICHARD F., Pittsburgh, Pa.
MULLER, FREDERICK L., Westfield, N. J.
MULLER, JULIUS H., Port Wentworth, Ga.
MURPHY, M. M., Chattanooga, Tenn.
NELSON, NORMAN E., Aberdeen, Wash.
NELSON, STANLEY ARVID, Rock Island, Ill.
OTT, THOMAS O., JR., Greenville, S. C.
PASOTTI, F. GEORGE, Muncie, Ind.
PEPPARD, WILLIAM D., Fort Wayne, Ind. (Re)
POPA, G., Chicago, Ill.
POSTON, J. C., Moose Jaw, Saskatchewan, Can.
PREEDOM, LOUIE M., Dallas, Tex. (Rt & T)
PRENDERGAST, JAMES J., Lawrence Park, Erie, Pa.
PRESS, BERNARD C., San Francisco, Calif.
RAMOND, ALBERT, Highland Park, Ill.
RANDOLPH, R. FITZ, Ithaca, N. Y.
REAGAN, C. H., Savannah, Ga.
REARDON, MICHAEL J., Chicago, Ill.
REIFENBERG, DAVID C., Indianapolis, Ind.
REISMAN, HOWARD H., Rock Island, Ill.
RIMSHA, VICTOR E., Chicago, Ill.
RING, FRANK, JR., Indianapolis, Ind. (Rt)
ROCKLIN, SAMUEL S., Washington, D. C. (Rt)
RUBINOWITZ, LEO, Washington, D. C. (Rt & T)
RYOH, BERNARD F., Akron, Ohio (Rt)
SCALA, THOMAS T., Bayonne, N. J.
SCHUBERT, ARNO A., Milwaukee, Wis. (Rt)
SEATON, P. CHARLES, Allentown, Pa.
SEMON, HOWARD W., Washington, D. C.
SHAW, MILTON C., Cambridge, Mass.
SIMON, CARL H., Williamsport, Pa.
SIMON, M. G., Tulsa, Okla.
SMITH, TURNER C., Whittier, Calif.
SPEIGHT, H. WILLIAM, Greenwich, Conn.
SQUIBB, EDWARD R., III, Scituate Center, Mass.
STOBIE, JOHN, Spokane, Wash.
SWANTON, JOHN R., JR., Cambridge, Mass.
TAYLOR, E. J., JR., Athens, Ohio (Rt & T)
THORN, FRED A., Seattle, Wash.
TOWNSEND, RAY T., Des Moines, Iowa
TREVORROW, FRANK W., Manhasset, N. Y.
TROY, M. O., JR., Atlanta, Ga.
TRUDEL, LOUIS, Montreal, Quebec, Can.
TULCINSKY, H. O., Liege, Belgium
VANDENBERG, JOHN, Enka, N. C.
VAUGHAN, WILLIAM, Southbridge, Mass.
WARD, JOSHUA JOHN, JR., Savannah, Ga.
WENSTON, ROBERT A., Pittsburgh, Pa.
WESTENHOLZ, TOM, Brooklyn, N. Y.
WHITE, GERALD S., Belmont, Mass.
WHITE, MERIT P., Whately, Mass.
WHITMAN, RICHARD F., Detroit, Mich.
WIEPKING, C. A., Milwaukee, Wis.
WINSLOW, CHARLES E., Oak Park, Ill.
WITHERINGTON, A., Birmingham, England
YOUNG, WILLIS H., JR., College Park, Md.
ZURCHER, ERNEST, Knoxville, Tenn.

CHANGE IN GRADING

Transfers to Fellow

ACKART, E. G., Wilmington, Del.
COLLINS, BERTRAND R. T., Princeton, N. J.
FERRIS, WALTER, Milwaukee, Wis.

Transfers to Member

BALLENGER, ROBERT D., Atlanta, Ga.
BOYKO, JOHN, Detroit, Mich.
CLOUSE, J. H., Coral Gables, Fla.
FERGUSON, ROBERT I., Milwaukee, Wis.
FRIGON, RAYMOND A., Montreal, Quebec, Can.
GOTTFRIED, H. W., JR., West Orange, N. J.
HART, JOHN J., Homestead, Pa.
HOPKINS, HAZEN RAY, Suffolk, Va.
LACROSSE, E., JR., Indianapolis, Ind.
LANE, PHILIP ELLISON, Brooklyn, N. Y.
LINDBERG, B. A., Boston, Mass.
LINSENMEYER, J. Z., East Pittsburgh, Pa.
PENTON, PAUL, Johnson City, N. Y.
POORMAN, GEORGE E., Washington, D. C.
PUTZ, T. J., Upper Darby, Pa.
SELLERS, WILLIAM N., Elizabethton, Tenn.
SMITH, TRAVER J., San Jose, Calif.
SPURLOCK, BENJAMIN H., JR., Boulder, Colo.
TARBOX, JOHN W., Ottawa, Ontario, Can.
WALKER, ROY PIERCE, Lompoc, Calif.
WALLACE, HENRY B., JR., Boston, Mass.
WEBER, PHILIP F., Elmhurst, N. Y.
WELANETZ, LUDOLPH FRISCH, West Annapolis, Md.
WILLITS, V. W., Dallas, Texas
YATES, MAX E., Richland, Wash.

Transfers from Student Member to Junior.....65

Necrology

THE deaths of the following members have recently been reported to headquarters:

CARLISLE, MORTEN, March 10, 1947
CONLON, WILLIAM T., March 10, 1947
ENGLISH, FRED S., January 11, 1947
FORD, HENRY, April 7, 1947
GARRETT, SEYMOUR S., February 13, 1947
GILL, THOMAS T., February 24, 1947
JEFFRIES, ERNEST, February 13, 1947
LOGAN, JOHN W., January 28, 1947
MCLAUTHLIN, MARTIN B., February 17, 1947
NIKONOW, JOHN P., March 1, 1947
PAINE, WALTER S., March 8, 1947
SCHMIDT, ARTHUR A., March 3, 1947

A.S.M.E. Transactions for April, 1947

THE April, 1947, issue of Transactions of the A.S.M.E. contains the following papers:

"Packaged" Boilers, by Martin Frisch and H. H. Hemenway
Cinder and Fly-Ash Factors When Burning Small Anthracite Coal on Traveling-Grate Stokers, by C. S. Gladden
Burning Low-Grade Midwestern Coals on Spreader Stokers With Continuous Ash Discharge, by J. M. Drabelle
The Removal of Deposits From Steam-Turbine Steam Passages, by G. B. Warren and T. W. Howard
Temperature Charts for Induction and Constant-Temperature Heating, by M. P. Heisler
Characteristics of Turbojet Engines at High Flight Speeds, by C. A. Meyer
Investigation of Flow in Liquids by Use of Birefringent Colloidal Solutions of Vanadium Pentoxide, by Philip Ullyott
The Shock Produced by a Collapsing Cavity in Water, by M. F. M. Osborne
The Analysis and Design of Servomechanisms, by Herbert Harris, Jr.

Better because it's Seatless

Why has this blow-off valve become "standard" in over 12,000 boiler plants? Why is it today the first choice of leading engineers for new boiler installations?

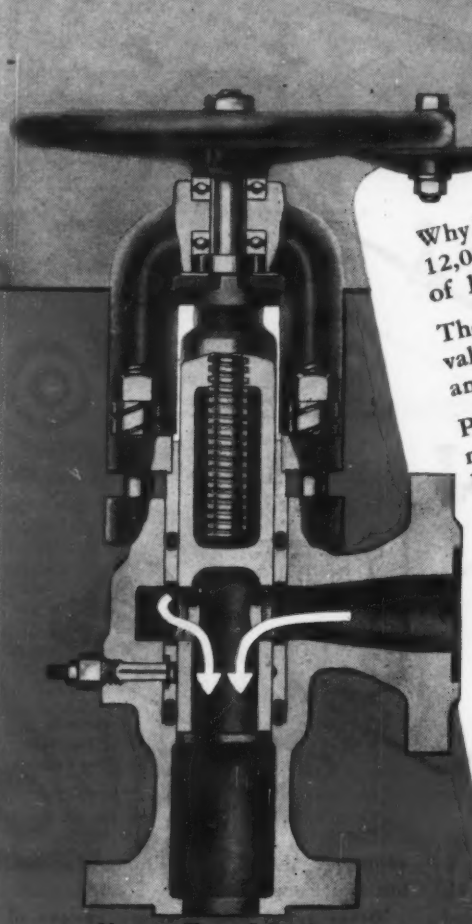
The answer is in the engineering reason behind the valve. It is *SEATLESS*. There is no seat to score, wear and clog with mud, scale and dirt.

Power plant operators hailed this seatless-design valve more than 25 years ago when it was first introduced. It eliminated a source of continual trouble and expense common with conventional type blow-off valves.

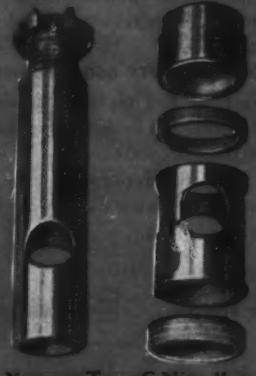
Since then constant mechanical and metallurgical research, aimed to meet new and more rigid service requirements, has made improved Yarway Seatless Blow-Off Valves the last word in insurance against boiler blow-down troubles.

See Yarway Blow-Off Valves, hear the seatless principle explained by Lowell Thomas in Yarway's color motion picture "There Is An Engineering Reason." It's available without charge for group showings. Write today.

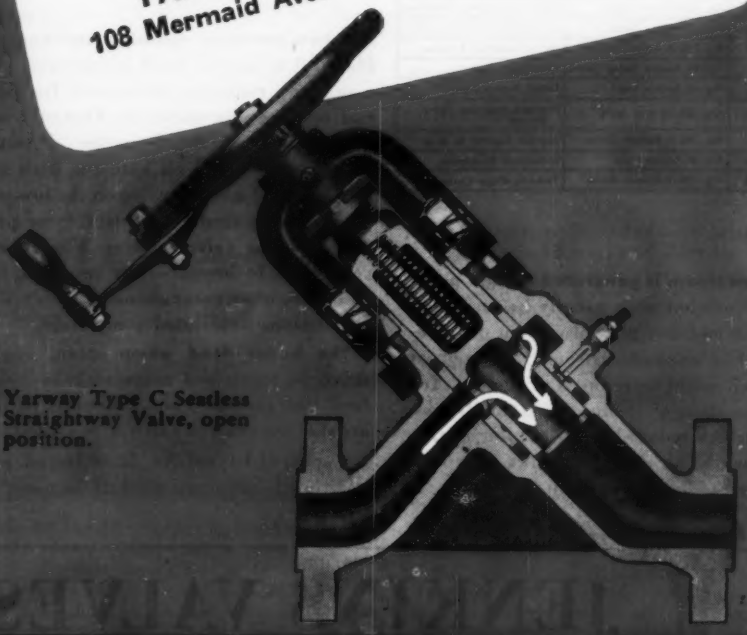
YARNALL-WARING COMPANY
108 Mermaid Ave. Philadelphia 18, Pa.



Yarway Type C Seatless Angle Valve, open position.



Yarway Type C Nitralloy Plunger, Glands and Improved Packing Rings.

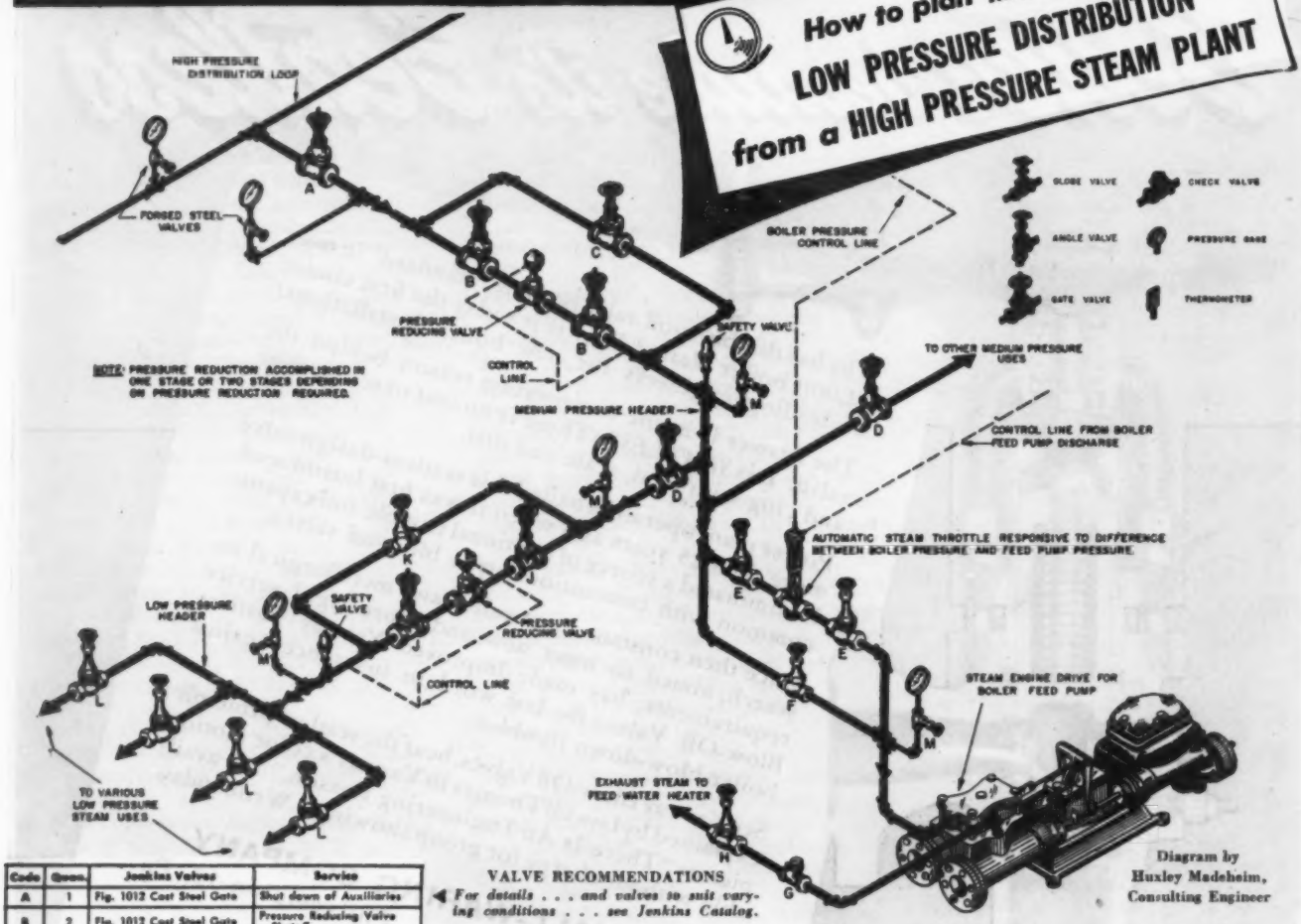


Yarway Type C Seatless Straightway Valve, open position.

YARWAY BLOW-OFF VALVES

Jenkins PRACTICAL PIPING LAYOUTS 22

How to plan MEDIUM and LOW PRESSURE DISTRIBUTION from a HIGH PRESSURE STEAM PLANT



Code	Quan.	Jenkins Valves	Service
A	1	Fig. 1012 Cast Steel Gate	Shut down of Auxiliaries
B	2	Fig. 1012 Cast Steel Gate	Pressure Reducing Valve Shutoff
C	1	Fig. 1042 Cast Steel Globe	Manual Control By-pass
D	2	Fig. 253 I.B.B.M. Gate	Individual System Shutdowns
E	2	Fig. 49 Bronze Gate	Automatic Throttle Shutoff
F	1	Fig. 106-A Bronze Globe	Manual Control By-pass
G	1	Fig. 92 Bronze Swing Check	Back flow check
H	1	Fig. 47 Bronze Gate	Steam Engine Exhaust
J	2	Fig. 253 I.B.B.M. Gate	Pressure Reducing Valve Shutoff
K	1	Fig. 106-A Bronze Globe	Manual Control By-pass
L	4	Fig. 47 Bronze Gate	Individual Shutdowns
M	4	Fig. 106-A Bronze Globe	Pressure Gage Control

VALVE RECOMMENDATIONS

◀ *For details . . . and valves to suit varying conditions . . . see Jenkins Catalog.*

Diagram by Huxley Madeheim, Consulting Engineer

● **When steam is generated at high pressure,** provision must usually be made for medium and low pressure steam distribution. For example, steam generated at 450 p.s.i. might be reduced to 100 p.s.i. for the operation of steam driven auxiliaries, and further reduced to 5 p.s.i. for heating purposes. The diagram shows a typical pressure reduction hookup.

The two pressure reducing stations are identical in layout. Each is provided with a pressure reducing valve good for dead end service, gate valves for shut-offs, and globe valves in the by-passes. Pressure gages are installed on both the high and low side, and a safety valve on the low side guarantees against the possibility of pressure-reducing valve failure. Where large reductions in pressures are required, two stages are often recommended, with reducing stations duplicated completely.

The boiler feed pump steam engine drive is controlled responsive to boiler feed line pressure, and a manual by-pass around the control valve is provided.

Copies of Layout No. 22, enlarged, with additional information, will be sent on request . . . also future Piping Layouts. Just mail coupon.

Other types and pressure ranges of Jenkins Valves can be used for this layout, according to factors involved. Consultation with accredited piping engineers and contractors is recommended on major installations.

A CHOICE OF OVER 600 JENKINS VALVES

To save time, to simplify planning, to get the advantages of Jenkins specialized valve engineering experience . . . select all valves from the Jenkins Catalog. Jenkins Valves assure *lowest cost in the long run.*

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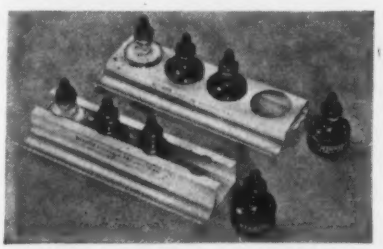
• NEW EQUIPMENT
• BUSINESS CHANGES
• LATEST CATALOGS

Available literature or information may be secured by writing direct to the manufacturer and mentioning MECHANICAL ENGINEERING as a source.

• NEW EQUIPMENT

Higgins Bottle Trays a New Item



Convenience for the millions of users of Higgins American Drawing Inks is the thought behind this tray. There are two types, an open and a closed tray. Higgins Ink Co., claim the open tray will be most popular with artists and in the school field, and the closed tray preferred by draftsmen. Both trays hold four desk bottles of Higgins American Drawing Inks and are of satin finish heavy gauge aluminum. Small holes in the bottom of the trays permit them to be attached to slanting drawing boards. The bottles may be readily removed from the open tray for close-up work. Bottles slide into a channel in the closed tray and are thus held securely, permitting the draftsman to extract the stopper with one hand. The trays will retail at $1.00 each.

New Model No. 920-S Machine by Acromark

Small studs or ignition points, of length $^{3}/_{16}'' \times {}^{1}/_{8}''$ diameter, required that a parts number be placed on the side of the head of each. An enlargement of the marked stud is shown in the illustration, and also the actual size of the studs are shown in comparison with the size of the machine.

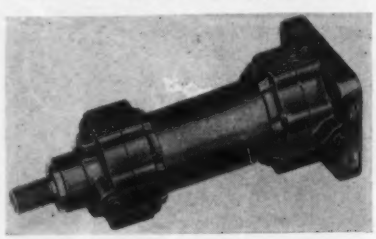
The results obtained by Acromark Engineers are interesting, in that this machine was developed, enabling the operator to swing the lever to the left at a right angle to the marking die, at which time a full dozen of the small studs were dropped into the holder in the manner of rivets in a riveting machine. Then a half swing of the operating lever carries the raised portion of the studs past the finely engraved marking die which rotates each stud and marks it around the head.

At the completion of the marking stroke all of the studs fall out on the left side of the machine due to the tilt of the machine itself on its angle base. Adjustment of the marking die inserts is accomplished by screws through a plate at the back of the holder which is held in position by screws through elongated holes in the holder. The inserts are removed by releasing a small set screw.

This is a very small unit, as will be noted by the comparative size of the hand and it is adaptable to use in the marking of other similar small pieces used in construction of fine instruments, watches, guns, etc.

Complete details will be gladly furnished upon application to The Acromark Co., 345 Morrell Street, Elizabeth, N. J.

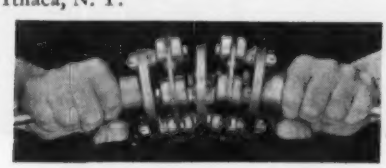
Standard Hydraulic Cylinders



Hannifin standard hydraulic cylinders, for service up to 1500 psi, are now available in two larger sizes, 7 and 8 inch bores. Design and construction parallel the standard Hannifin cylinders in 1 to 6 inch sizes, with bored and honed cylinder bodies; automotive type piston rings; and interchangeable end caps. Nine standard mounting styles are available, with standard rod, large (2 to 1) rod, or double end rod. Hannifin Corp., 1101 South Kilbourne Ave., Chicago 24.

Double Morflex Couplings

Double Morflex couplings (a universal-joint type) are now in full production, according to Morse Chain Co., Detroit 8, Mich. and Ithaca, N. Y.

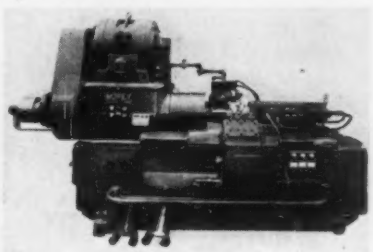


Since the Double Morflex is, in effect, two single Morflex couplings with a center plate adapter, the new model has twice the torsional resilience (softness) of the single coupling. Torsional resilience is obtained through the preloaded Neoprene biscuit construction. Acting as a universal drive connection, the double coupling accommodates offset and angular misalignment of shafts.

The double Morflex permits constant velocity between driving and driven member. With no metal-to-metal contact, Morflex requires no lubrication, is proof against noise and vibration, reduces bearing wear, and is dielectric.

The double coupling is available in 10 sizes, in capacities of 13 to 725 foot pounds of torque.

Machining of Steering Knuckles



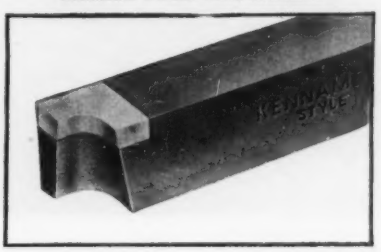
Automotive Steering Knuckles are machined on the Morey #19 Production Lathe, in one operation from the rough forging to the finished turned size after parts have been centered.

Description of this new efficient method, showing tooling lay-out, time study and substantial savings in machining costs, is available on request.

The Morey #19 Production Lathe is a hydraulically operated, electrically controlled high production machine, with an automatic work cycle. The machining operations include facing, chamfering, straight taper or contour turning in two separate speed ranges which are automatically selected. Extreme rigidity make it possible to handle eccentric forgings and to use Tungsten carbide tools at their maximum efficiency.

For information and bulletin write to Morey Machinery Co., 457 26th Ave., Astoria, New York 2, N. Y.

Introduces Standard Internal Radius Tools and Blanks



Kennametal Inc., Latrobe, Pa. announces the development of a standard line of internal radius tools and blanks for rounding the corners of machine parts. Such tools have heretofore been made special to suit individual requirements. As supplied they are form ground to hold contour when reground on the top surface only.

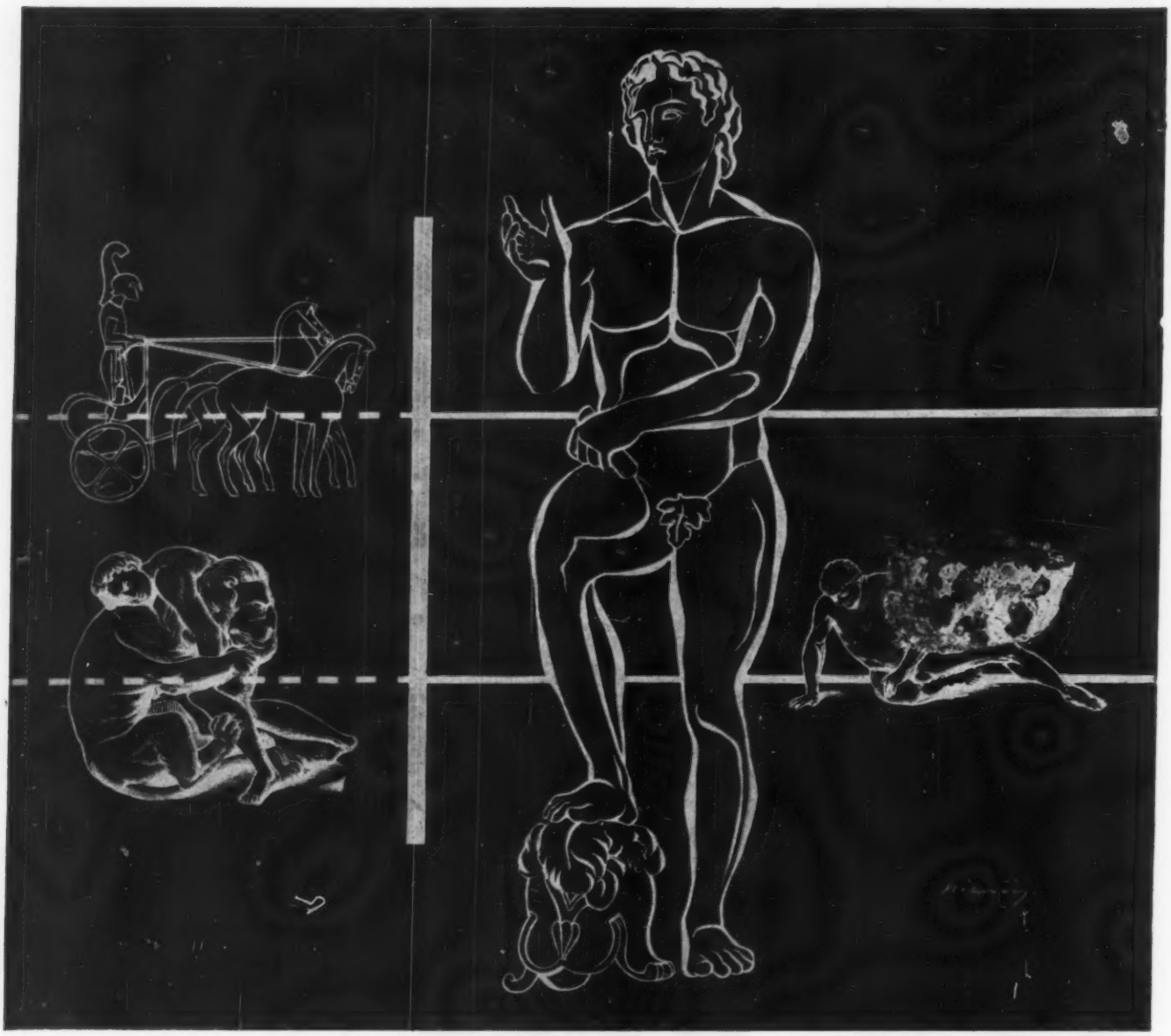
Through experience, Kennametal Inc. has been able to establish the sizes of internal radius tools most frequently required. These

Continued on Page 37

IT TAKES MORE THAN MUSCLE

According to legend, Polydamas, the Greek athlete, killed a lion with his bare hands, stopped a chariot in full flight, and lifted a raging bull off the ground with ease. His career, however, came to a spectacular end when he tried to catch a huge falling rock.

Today, sudden, heavy loads end the life of many steel parts. Low temperatures, for instance, can have a depressing effect on the impact strength of steels. Molybdenum steels, which combine deep hardening and freedom from temper brittleness, reduce this risk.



MOLYBDIC OXIDE—BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"
CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

Climax Molybdenum Company
500 Fifth Avenue · New York City

MOLY

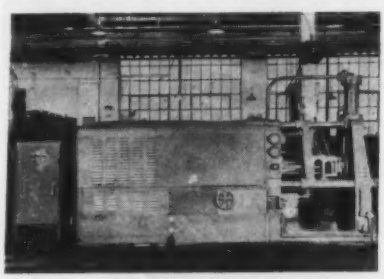
• Keep Informed

sizes have been cataloged (complete tools—Style FR; blanks—Style R) and are for forming corners of the following radii: 3/32", 1/8", 5/32", 3/16", 7/32", 1/4", 9/32", 5/16", 11/32", 3/8", 7/16", and 1/2".

Kennametal Grade K3H is recommended for machining corners on steel; Grade K6 for machining cast iron, brass, bronze, and light alloys.

Orville Wright Witnesses First Public Demonstration of Magnesium Die Casting

Amongst 5000 scientists, technicians, industrialists, Army and Navy Officers etc., who visited the Magnesium Exhibit jointly sponsored by the Air Material Command, Army Air Forces and the Magnesium Association at Wright Field, Dayton, Ohio on February 18th to 20th, was also a pioneer of aircraft production, Orville Wright.



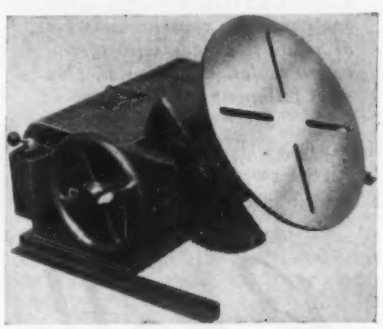
For the first time in history magnesium was die cast publicly by Hydropress, Inc. of New York, on one of their Standard "Hydrocast" Die Casting Machines, designed for all non-ferrous metals.

The Operation of this self contained, semi-automatic cold chamber die casting machine of 40,000 lbs. injection pressure and 300,000 lbs. clamping pressure, has shown to the public and to the industry that magnesium, when properly handled on appropriate equipment, is not subject to any greater fire hazard than any other material.

The Metal was melted and kept at its casting temperature in an electric furnace which was adjusted to avoid any danger of oxidation.

The great variety of products manufactured from magnesium, the structural metal of the future, has given good evidence of its adaptability for many industrial and domestic uses.

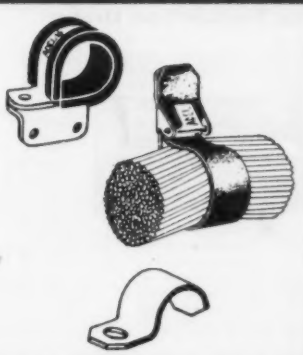
Power-Operated Bench Model 1-P Positioner



A power-operated bench model positioner for work weighing 100 lbs. or less is Ransome's answer to increased demands for a faster, more efficient tool for positioning small work in shops and educational and industrial laboratories. Built to handle small units, the Model 1-P is a versatile machine that facilitates welding, assembling, repairing,

Continued on Page 38

ADEL LINE SUPPORT CLIPS

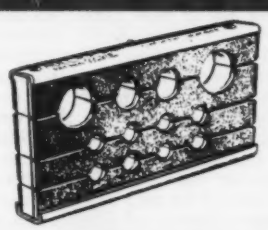


ADEL Clips provide a simple, rugged, low cost support for tubing, piping and electrical cables. Manufactured in over 13,000 different types and sizes. Over 330 million now giving dependable support in aircraft, marine and industrial installations.

ADEL Shock Absorbing Clips give cushioned support—insulate lines from vibration and wear.

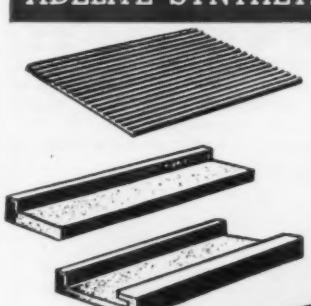
ADEL Cable Harness Straps are self-adjusting supports accommodating single cables or any combination of wires. Positive locking device permits easy repair or replacement of wires. Loads to 2800 lbs.

ADEL LINE SUPPORT BLOCKS



A low cost, easily installed support for multiple grouping of lines. Provides rugged, resilient support eliminating line failures and fitting leakage caused by vibration. Available with hard maple, phenolic or **ADELITE** blocks in wide variety of sizes for accommodating 1 to 30 lines, ⅛" to 2½" in diameter.

ADELITE SYNTHETIC RUBBER



ADELITE—a tough, wear-resistant compound 26 to 33% lighter than conventional synthetic rubber. Impervious to aromatic vapors and liquids. Extremely low compression set. Permanent resiliency. Excellent sound insulating characteristics. Any hardness from 30 to 80 Shore Durometer. Available in wide variety patterns including channels, gaskets, pads, floor coverings and other molded forms.

Write for illustrated catalog containing complete specifications on more than 13,000 ADEL Clips and Blocks for aircraft, industrial and marine service.

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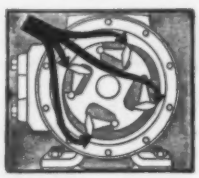
ADEL PRECISION PRODUCTS CORP.
BURBANK, CALIF. ★ HUNTINGTON, W. VA.

Manufacturers of: Aircraft Hydraulic Systems • Marine & Industrial ISOdraulic Controls • Halfco Self-Aligning Bearings • Line Support Clips & Blocks • Industrial Hydraulic Equipment • Aircraft Valves • Industrial Valves

DEPENDABLE PUMPS for
DEPENDABLE MACHINES & PROCESSING EQUIPMENT
BLACKMER ROTARIES
are
SELF-ADJUSTING FOR WEAR

SUSTAINED CAPACITY



"Bucket" design (swinging vane principle) automatically compensates for wear.

20 years of service is not unusual for a Blackmer pump.

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Bulletin No 307—Facts about Rotary Pumps
Bulletin No. 302—Pump Engineering Data

BLACKMER PUMP COMPANY
1920 Century Ave. Grand Rapids 9, Mich.
Capacities to 750 GPM Pressures to 300 psi

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LZY-KLEEN STRAINERS

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Minimum Maintenance
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Restores Old Bridges
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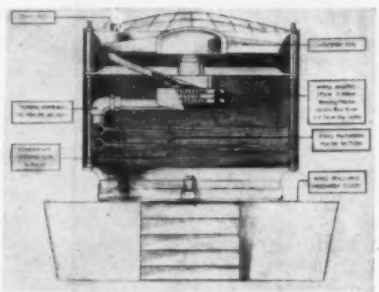
grinding, hard surfacing, and similar operations for positioning the work to the best advantage for the operator. Work may be tilted to 135 degrees and locked in any position at any degree of tilt. It may also be revolved 360 degrees by a 1/6 h.p. single phase reversible motor. A disengaging clutch permits free wheeling when desired. Lever-operated vari-drive pulley permits a speed range from .21 to 5 r.p.m.

Ransome manufactures welding and work positioners from 100 lb. hand- and motor-operated to 40,000 motor-operated, as well as turning rolls and other special positioning equipment. For further information, write the Industrial Division, Ransome Machinery Co., Dept. P-50, Dunellen, New Jersey, a subsidiary of Worthington Pump & Machinery Corp.

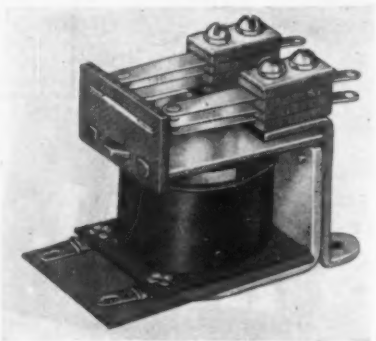
Source of Heat Operates Fan in Wing Turbine Unit Heater



A welcome development in view of the electric motor situation is the introduction of the Wing Turbine Revolving Unit Heater by L. J. Wing Mfg. Co. of New York. In this, the fan is driven by a remarkably compact Wing all-steel steam turbine. The turbine exhaust passes into the heater section where it is used to heat the air which the turbine-driven fan then delivers through the Wing revolving discharge outlets to the working level below. Condensate, which is never at a higher temperature than 170° F. is returned to the boiler through an open return system. The advantages claimed are elimination of electric motor and electric power, no back pressure, no packing, no traps.

New Compact Midget Relay

This Series 600 Guardian Relay is designed and priced to meet industrial needs for a small, compact, low cost relay, yet it is capable of performance equal to many larger and more expensive relays. It possesses many unique features which make it readily acceptable.



The Guardian Series 600 relay is attractive to design engineers because it can be furnished with innumerable contact switch combinations up to and including four pole, double throw. Also, the short contact

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blades in the switch assembly eliminate intermittent contact or contact "bounce."

The Guardian Series 600 Relay is comprised of two basic parts—a coil assembly and a contact assembly. Each basic part is interchangeable. For example, the contact assembly can be used with any of the standard Series 600 or 605 coils whether the operating voltage is 3, 6, 12, 18, 24, 32, 50, 115, 230 A.C. or 3, 6, 12, 18, 24, 32, 50, 110, D.C. The maximum contact current capacity is 8 amperes and power consumption is 6 V.A. This relay will pass underwriters' specifications.

For additional information write Guardian Electric Mfg. Co., Dept. 600, 1619 West Walnut Street, Chicago 12, Ill.

AP-MO Electrodes Announced by Westinghouse

For direct-current reverse polarity welding only of low alloy cast steel or low alloy high tensile strength rolled steels in all positions, the new AP-MO electrode, available in three diameters from 1/8-inch to 3/16-inch, is announced by Westinghouse Electric Corp.

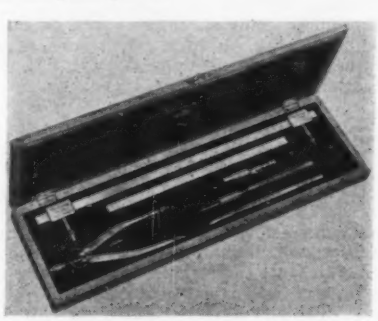
This electrode is designed for making butt and fillet welds in all positions and welds made with it meet the requirements of AWS-ASTM tentative specifications for Iron and Steel Arc Welding Electrodes Classification E-7010.

Further information on the AP-MO electrode may be secured from P. O. Box 868, Westinghouse Electric Corp., Pittsburgh 30, Pa.

New Bruning Drawing Set Has Many Unusual Features

New features and advantages are embodied in an industrial drawing set just introduced by Charles Bruning Co.

The instruments in the set consist of Beam Compass with 8-inch and 13-inch beams—a 6-inch giant Bow Compass—Ruling Pen with club style wood handle and Draftsman's Refillable Pencil that can be converted into a double point pencil.



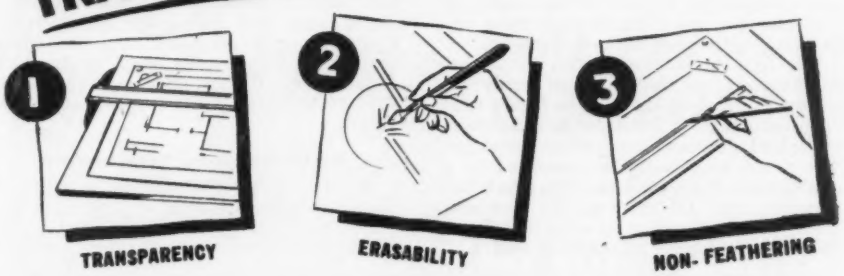
An exclusive patented feature of the Bruning Beam Compass is a rapid, simple and positive adjustment of the needle and pencil blocks on the beam. A slight pressure of the thumb on the tension spring of the blocks allows the needle and pencil blocks to move freely and smoothly on the beam—yet release of pressure locks the needle and pencil firmly in desired position.

A new patented feature of the Ruling Pen is the calibrated adjusting collet that enables the user to regulate the opening of the nibs and at the same time record the desired setting for future use. With this patented device, the desired width of line, when indexed, can easily be duplicated by re-setting the pen to the original index, thus making it possible to maintain lines of uniform width.

The new Giant Bow Compass also has a new patented feature: the lead of the pencil

Continued on Page 40

GIVE YOUR TRACING CLOTH the 1·2·3·test–



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Whatever you want most in a tracing cloth, you'll find it in these two great products of Holliston Mills. Try them both and you'll agree: it pays to make sure you get "all three": maximum transparency and maximum erasability and minimum feathering.

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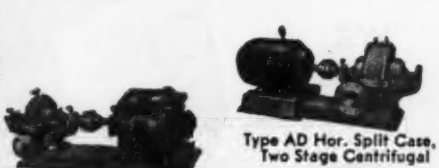
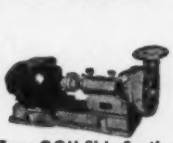
SIZES FOR EVERY DUTY, LARGE OR SMALL



Type AD Hor. Split Case, Two Stage Centrifugal

Type OD Hor. Split-Case Double Suction Single Stage Centrifugal

APCO Horizontal Condensation Return Unit



Type GGU Side Suction Single Stage Centrifugal

APCO Single Stage Turbine-Type

Type GMC Close-Coupled Centrifugal

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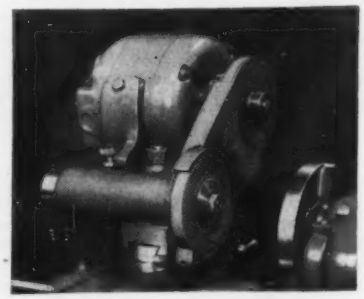
part can easily be advanced by slightly turning the adjusting collar of the chuck. The lead is advanced to the desired length for easy sharpening without soiling fingers or smudging tracings. The compass draws circles from 1/16 inch to 8 inches in diameter.

The Bruning Drafting Pencil has a patented metal chuck that grips lead evenly and snugly, distributing the pressure over a wide area and thus eliminating scoring and nicking of the lead, a common cause of lead breakage. The pencil may easily be converted to a double point pencil with an extra chuck and matching tip. The extra tip has been anodized, slightly changing its color to differentiate between degrees of lead being used.

Though moderate in price, the new Bruning instruments are high in quality, Bruning officials says. Materials used in construction are satin-finish aluminum, chrome-plated steel and high-grade spring steel. Complete set is assembled in a flock-lined natural finish mahogany case. Address all Inquiries to Charles Bruning Company, 4754-18 Montrose Avenue, Chicago 41, Illinois.

Lathe Grinding Attachment

A powerful electric grinding attachment for use on lathes and other machine tools has been developed by the South Bend Lathe Works. Designed primarily for precision external grinding, it is equipped with a 4" × 1/2" grinding wheel which is driven by a constant speed continuous duty 1/4 h.p. motor. This permits taking heavier sustained cuts than would be practical with a universal type motor of the same rated horsepower. Available with frame sizes to fit the various sizes of South Bend Lathes, this grinding attachment can easily be adapted to other makes of lathes, milling machines, shapers, planers, etc.



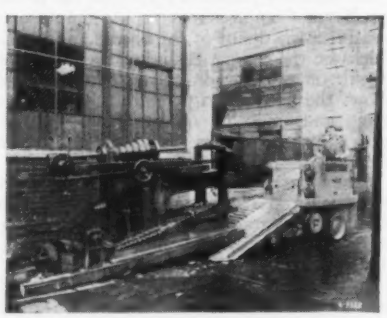
The grinding wheel spindle runs on prelubricated sealed precision ball bearings which require no adjustment or additional lubrication. Effectively protected from abrasive grinding wheel dust, the sealed bearings will retain their precision indefinitely. Tension adjustment is provided for the V-belt which connects the motor with the grinding wheel spindle. Both the grinding wheel and the V-belt are enclosed in a single guard.

Spring stops for grinding straight and spiral fluted reamers and cutters, diamond dressers for truing the grinding wheel, and holding fixtures for the dressers can be furnished for use with this grinding attachment. Grinding wheels are available in several grades for grinding various materials including tungsten carbide, tool steel, machine steel, cast iron, brass or bronze, aluminum, Bakelite, hard rubber, and soft rubber. Special cup wheels are supplied for reamer and cutter grinding.

For more complete information, catalog, and prices of this grinding attachment, write to the South Bend Lathe Works, 385 E. Madison St., South Bend 22, Ind.

Roller-Ramp Variant of Platform Truck for Manipulating Extra Heavy Loads

The ingenuity of The Yale & Towne Mfg. Co. has begotten a new variation of the heavy-duty power truck, designed for the easier manipulation of massive machinery and crates into carrying position by means of an integral roller-ramp and cable-draw system. The new device is called the Gravity Tilting Platform type of electric truck.



As is clear from the illustration, the roller platform falls into ramp position when unlatched by the operator, and winch-drawn cables encircle the load to pull it onto the

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ramp and cause the ramp to rock back into the horizontal transporting position. Three pulling levels for the cable lines may be used, the lowest being direct from the cable drum (for very dense and low loads such as steel plate). The higher idler sheaves are employed to obtain higher purchases on such loads as machinery and bulky crates.

When empty, the roller platform is so balanced that virtually no effort is required to rock it into the horizontal position for empty return trips.

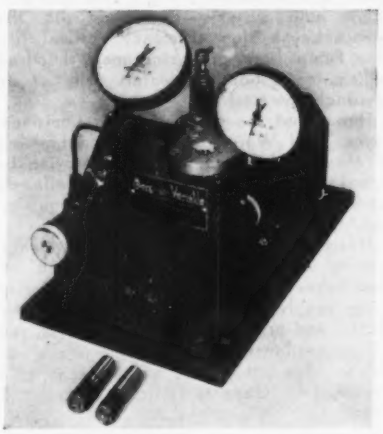
When running loaded, it is recommended that the pulling cables be left in position to hold the load engaged and prevent it from vibrating on the platform—and to save time in re-rigging for the unloading operation. This, however, is not necessary.

The truck body, the drive and the control equipment are all designed on the extra-heavy side. All six wheels are actuated by shockless worm-wheel steer.

Here, again, is further evidence that the benefits of standard electric truck handling have become so important to industry that special adaptations for special situations are ever widening.

Merz "New-Matic" Gages Offer "Reversed-Flow" Air Control in All Models

To meet industry's growing demand for precision gages, Merz Engineering Co., Indianapolis, Ind., has developed and produced a complete line of pneumatic and taper gages, known as "New-Matic" with "reversed-flow" air control featured in all models.



The "reversed-flow" principle was developed in its entirety by the Merz Engineering staff and is found exclusively in Merz "New-Matic" Gages. This feature provides both a calibrated measurement scale of the required magnification and a "zero" adjustment for returning the calibration to a basic value. To obtain this extremely accurate inspection device, Merz "New-Matic" Gages are equipped with continuously variable and adjustable orifices, making possible the control of air volume, as well as air pressure, and providing "balanced air" for high-precision measurement.

Merz "New-Matic" Gages are not merely comparators but are actual measuring machines, as well. Variations from standard dimensions are shown on scales or dials in graduations to meet customers' requirements.

Merz "New-Matic" Gages are made in five models to fit inspection requirements of every type—in the gage laboratory, on high-speed production operation, for checking finished dimensions at the machines.

Continued on Page 42

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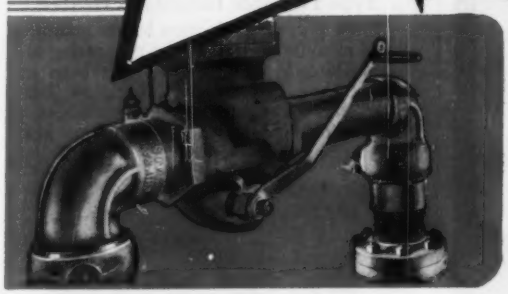
THE PERFECT COMBINATION For LOADING LINES

Okadee LOADING RACK VALVES



OKADEE LOADING RACK VALVES are now distributed exclusively by Chiksan Company and Chiksan Export Company. Okadee Valves have been "working on the railroad" for 50 years... and serving the Petroleum Industry for a quarter-century. The combination of Chiksan and Okadee now makes possible uniformly high standards in Loading Rack design and performance.

CHIKSAN SWIVEL JOINTS have always been noted for their unobstructed inside diameter which permits full flow. Okadee Loading Rack Valves provide corresponding high capacity. In combination, they improve loading efficiency and substantially reduce loading time. Low pressure drop saves pumping costs. Non-shock closing prevents damage to equipment. Easy operation at all pressures gives the operator perfect control. Chiksan Ball-Bearing Swivel Joints provide full 360° rotation with low torque. There is nothing to tighten or adjust. You get ALL these advantages when you specify Chiksan and Okadee for Loading Rack service. Write for full details.

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CHIKSAN TRADE MARK REGISTERED BALL BEARING SWIVEL JOINTS FOR ALL PURPOSES

CHIKSAN COMPANY
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Investigate

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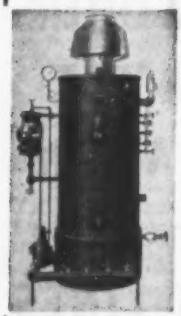

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Engineered Steam assures you of an adequate supply of steam for your process equipment . . . where you need it, when you need it . . . with minimum supervision and maintenance. Its components include: the study and solution of your steam requirements; the KANE Boiler, properly sized and constructed, to fit your needs; the Necessary Controls to provide constant steam pressure and temperature; the M-K-O Automatic Boiler Feed to maintain the water level for highest boiler efficiency; and the Engineering and Manufacturing Experience to insure economical, efficient and trouble-free operation.

Although current demands cannot be supplied immediately, we'll try to fill your urgent needs as soon as we can.

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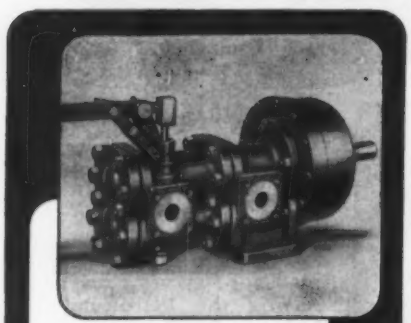
1903-1915 EAST HAGERT STREET, PHILADELPHIA 25, PA.
FOUR DECADES OF AUTOMATIC GAS-FIRED BOILER MANUFACTURING EXPERIENCE



IMO reversible hydraulic motor permitting infinite speed variation in either direction.

IMO POWER UNIT

The IMO principle embodied in a hydraulic motor makes an exceptionally simple, compact and reliable device for hydraulic power transmission.

IMO hydraulic motors can be furnished for operation at varying speeds in either direction with corresponding variation in output.

For information send for catalog I-130 -A

IMO PUMP DIVISION
of the
DE LAVAL STEAM TURBINE CO.
TRENTON 2, NEW JERSEY

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The Merz "Master" "New-Matic" offers a standard calibrated scale for any required magnification up to 20,000/1. The Merz "Versatile" "New-Matic" provides a normal scale covering .004" and magnification of approximately 1,000/1.

A complete variety of standard and specially-built accessories are available for use with Merz "New-Matic" Gages. All accessories are equipped with synthetic ruby contacts and tungsten carbide inserts, for maximum wear and precision. The use of Setting Masters is unnecessary.

Operation of Merz "New-Matic" Gages requires no special training or technical knowledge—gage readings are as easy as telling time on a clock. Installation is easy and economical, air consumption exceptionally low. All models are ruggedly built and handsomely designed. Gage cases are of wrinkle-finish black metal with chromium trim.

Merz Taper Gages consist of two Merz "New-Matic" Gages, equipped with a special fixture incorporating large and small taper-gaging rings of hard steel. Taper variations are registered on one gage to plus or minus 30′ in graduations of 5′— or, if preferred, to plus or minus 10′ in graduations of 1′. Out-of-round condition is shown simultaneously on the second dial in graduations of .0001, to a total of .002.

In addition to "New-Matic" Measuring Machines and "New-Matic" Taper Gages, the Merz Engineering Company designs and produces A.G.D. standard and special gages, tools, dies and handles experimental projects. Complete information on Merz products and services may be obtained from company representatives, located in most major cities, or from the company's main office, 200 S. Harding St., Indianapolis 7, Indiana.

Electric Arc Introduces New Unit Type Portable Induction Heater

A new portable induction heater manufactured in units of 10 kva. for preheating and normalizing for welding has just been announced by Electric Arc, Inc., 54 Jelliff Ave., Newark 8, N. J., manufacturers of Smith-Dolan low frequency induction heating equipment.

The new Model UP Induction Heater was developed primarily for its flexibility and adaptability to a wide range of applications and capacities, thus eliminating the necessity of stocking a number of heaters in several capacities to handle large and small work. A minimum amount of equipment is necessary. The individual units of 10 kva. each

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OPERATION COST
SCORES IN LOUISIANA

Louisiana with her wide diversification of industries, thriving cities and vast areas of irrigated rice lands has in use more than six hundred and thirty Layne Well Water Systems. These skillfully engineered and precision built systems—equipped with the famous Layne high efficiency Vertical Turbine Pumps, are producing many hundred millions of gallons of water daily at an amazingly low cost.

Throughout the entire state of Louisiana, Layne Well Water Systems far outnumber all other kinds combined . . . . proving by actual use that Layne equipment is definitely superior in high efficiency, rugged quality, and long life.

Nearly seventy years of specialized engineering experience and research stand behind Layne Well Water Systems. For your water supply needs . . . . if quality, efficiency, and proven long life are factors, you will unquestionably prefer Layne Wells and Pumps. For literature address Layne & Bowler, Inc., General Offices, Memphis 8, Tenn.

PUMPS For

Wells—Lakes—Rivers—Reservoirs—Irrigation Projects—are obtainable in sizes from 40 to 16,000 gallons per minute, powered by electric motor, V-belt or angle gear drives. Write for Pump Catalog.

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WELL WATER SYSTEMS
VERTICAL TURBINE PUMPS

AFFILIATED COMPANIES: Layne-Arkansas Co., Stuttgart, Ark. ★ Layne-Atlantic Co., Norfolk, Va. ★ Layne-Central Co., Memphis, Tenn. ★ Layne-Northern Co., Mishawaka, Ind. ★ Layne-Louisiana Co., Lake Charles, La., ★ Louisiana Well Co., Monroe, La. ★ Layne-New York Co., New York City ★ Layne-Northwest Co., Milwaukee, Wis. ★ Layne-Ohio Co., Columbus, Ohio ★ Layne-Pacific, Inc., Seattle, Wash. ★ Layne-Texas Co., Houston, Texas ★ Layne-Western Co., Kansas City, Mo. ★ Layne-Western Co. of Minn., Minneapolis, Minn. ★ International Water Supply Ltd., London, Ont., Can. ★ Layne-Hispano Americana, S. A., Mexico, D. F.

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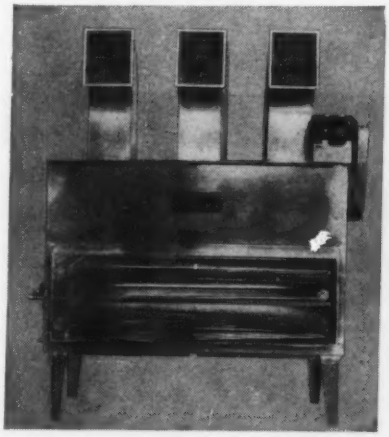
may be stacked on the job to form groups of 2 and 3 units with capacities of 20 and 30 kva., to obtain sufficient heater capacity for preheating and normalizing welded joints on pipes of larger diameters. The 30 kva. group, for instance, is capable of preheating a 10 in. pipe joint to 1300°F. in 2 hours.

Extremely compact, the UP Heater is especially useful in a limited space and crowded conditions and can be kept close to the work. An adaptation of the well known Smith-Dolan System, each unit is complete in itself containing power unit, contactor, meters and control supply. Heating current and voltage output variations are brought about by an ingenious selector switch built into the unit and readily accessible. Controlling pyrometers and program controllers can be plugged into the Induction Heater in two polarized receptacles for recording job temperatures and heat cycles. Polarized receptacles are also provided for the interconnection of the heater into groups and for the power supply to the units.

Preheating and normalizing welds constitute but one of the many uses of the Model UP. They can be successfully used for thawing large water lines, testing high current power bus connections, testing current transformers, supplying phantom loads for testing relays on power systems, resistance heating for brazing and soldering, shrink-fitting, heating for straightening, drying water soaked rotors and stators and many other such uses.

Niagara Blower High Pressure System Fan Heater

The Niagara High Pressure System Fan Heater uses a dual coil system to obtain complete utilization of both the latent and sensible heat of high pressure steam in heating—eliminating complex secondary piping, reducing stations and accessories. This coil system is installed in a fan heater of standard design in which air is drawn through the heater by centrifugal fans.



The high pressure steam is condensed in a finned coil, the condensate flowing into a trap from which it is admitted to the regenerative vapor coil entering header where it flashes into vapor. Any of the high pressure condensate remaining liquid at this point is drained directly to the final condensate return header by a hairpin bend tube from which this condensate gives off its heat into the air stream.

The vapor condensing coil has its top (or vapor) leg finned and steeply pitched. The lower (or condensate return) leg is relatively flat, leading to the condensate return header in which there is a weir that keeps the liquid level high in this leg where it is in contact

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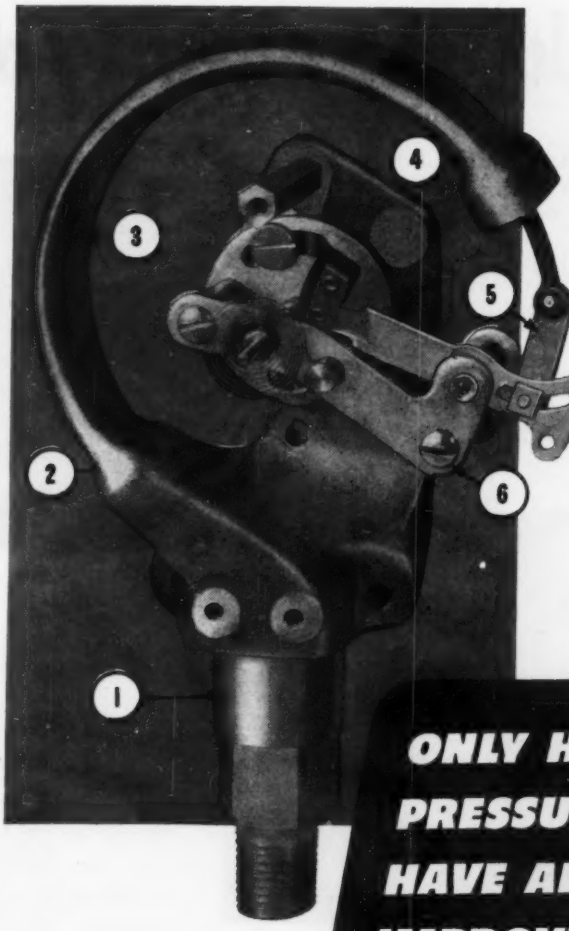


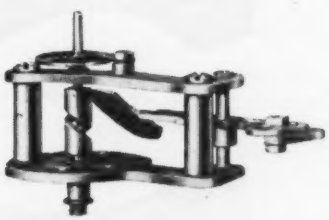
1. One-piece, drop-forged steel socket of streamlined design
2. Socket fused to KOREX steel Bourdon Tube
3. KOREX Bourdon Tube has smooth inner surface devoid of microscopic cracks
4. Forged steel tip fused to KOREX Bourdon Tube
5. Connecting link and screws of hard stainless steel, chrome plated and polished
6. Stainless Helicoid movement

ONLY HELICOID PRESSURE GAGES HAVE ALL THESE IMPROVEMENTS

These are not all the improved features of Helicoid Pressure Gages. They do serve to illustrate the fact that Helicoid is a better gage—one that will take the punishment of hard use and remain accurate through a longer life. Experience proves that a Helicoid Gage with KOREX Steel Bourdon Tube will safely withstand pressures of 50% in excess of the total dial graduation.

Many large users of gages have standardized on Helicoid. Write for our complete catalog which tells why.

In the Helicoid movement, contact between a polished, graphited Bakelite cam and a polished helical groove replaces the conventional gear and segment. Only Helicoid gages have this movement.



ACCO

HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE

TRADE MARK

Welded Steel Cuts Cost 27%

By C. D. Bonifield
Vice-President in Charge of Production
The Globe Company, Chicago, Ill.

IN our development program of continually improving the designs and production of our machinery for the meat packing industry, we have found it helpful to think in terms of arc welded steel construction. This affords a highly flexible approach to our problems and the end result is beneficial to the users of our products, the welded designs being strong, rigid, light-weight and of smooth, sanitary surfaces.

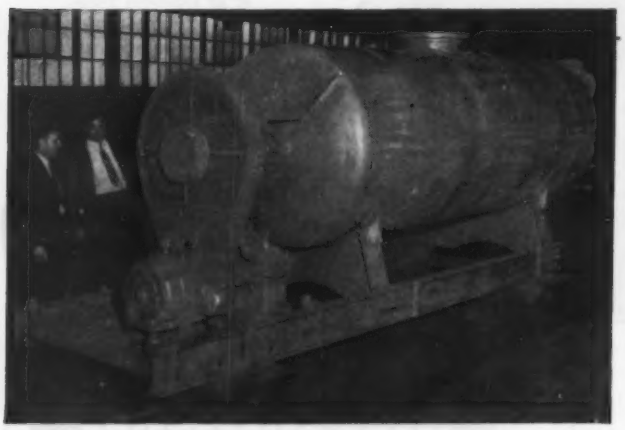


Fig. 1. Dry rendering cooker of welded construction.

One design which has been changed recently to welded steel construction is the saddle for the dry rendering cooker shown in Fig. 1. Two of these saddles support the welded pressure vessel on the welded base of this machine.

Fig. 2. Saddle support member of former design.

Fig. 3. Welded steel saddle costs 27% less than former design.

Fig. 4. Fixture used for assembly of welded saddle.

A saddle of former construction is shown in Fig. 2. The welded steel saddle, shown in Fig. 3, is produced at a total saving of 27% in cost over the former design.

The welded saddle, 60″ wide, 24″ high and 8″ deep, is fabricated from ½″ mild steel plate, consisting of four pieces, flame-cut and brake formed. The parts are assembled in the welded fixture shown in Fig. 4, which is placed on a work table in the flat position. After tack welding the parts together, the assembly is removed from the fixture and finish welded as shown in Fig. 5, with the saddle positioned for downhand welding of all joints. This requires continuous, two-pass fillets on both sides to join the flange to the web. The end pieces of the flange are butt-welded on both sides to the top flange assembly.

Fig. 5. Joints are positioned for downhand welding.

In approaching designing problems, our engineers have been aided by the Studies in Machine Design published by Lincoln Electric. These can be secured by writing to THE LINCOLN ELECTRIC COMPANY, Dept 372, Cleveland 1, Ohio.

• Keep Informed

with the coldest portion of the air stream. This sub-cools the condensate below its relative return temperature. The weir has a bleed hole for draining the condensate upon shut-down.

From the vapor coil condensate return header the condensate is withdrawn into the return system to the boiler. Vacuum return is vaporfree and fully efficient, returning the condensate evenly and without flashing, at low pressure and temperature.

Niagara High Pressure Fan Heaters are patented and are manufactured in custom sizes especially for large scale installations, by the Niagara Blower Co., 405 Lexington Ave., New York 17, N. Y.

New Oscillograph Facilitates Television Waveform Studies

Intricate television waveforms even to those in a single scanning line and to a fraction of that line, are picked out, expanded either vertically or horizontally, and can be recorded when desired, by means of the new Du Mont Type 280 Oscillograph just announced by Allen B. Du Mont Laboratories, Inc., of Passiac, N. J. This instrument provides means for accurately determining (a) the duration and shape of various waveforms contained in the composite television signal, and (b) the character of the picture-signal video in conjunction with transmitter operation according to FCC standards and practices.

The Type 280 cathode-ray oscillograph is made up of four units, each mounted on a standard relay-rack panel and chassis. All four units are installed on a rack equipped with casters for convenient mobility. Removable side and rear panels provide ready accessibility to working details. Panel controls are grouped to facilitate operation. The indicator is the Type 5RP-A cathode-ray tube with three post-deflection intensifier electrodes, allowing high ratios of intensifier-to-second-anode voltage without distortion of pattern and without great sacrifice in deflection sensitivity. The best combination of pattern brilliance and deflection sensitivity is provided by an overall accelerating potential variable from 7,000 to 12,000 volts, while an auxiliary focus control assures a fine, clear focus over the entire length of trace. The mounting bezel permits attachment of the Du Mont recording camera or the projection lens for large-screen studies.

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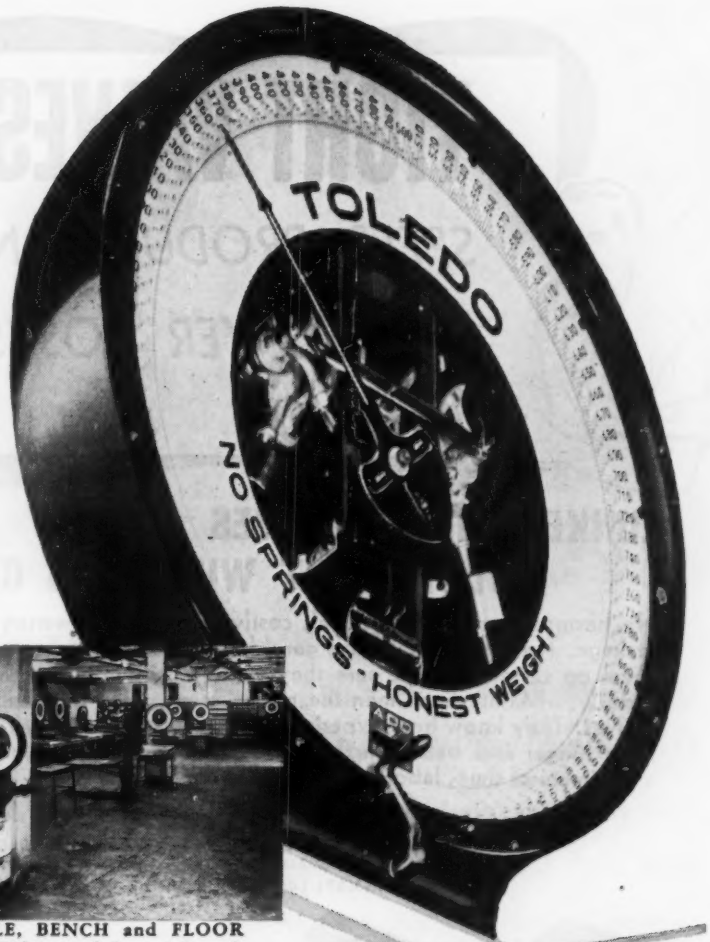


PORTABLE, BENCH and FLOOR SCALES—Widely used for weight-and-cost-control in modern plants.

OVER-UNDER SCALES—The Speed-weigh saves time in packing, filling, check weighing.

COUNTING SCALES—These Toledo Scales count small parts rapidly and accurately.

TOLEDO KNOW-HOW HELPS YOU

Know Your Costs!

● Accurate job-fitted Toledo Scales can help you prevent waste of time and materials . . . improve product-quality . . . increase production . . . and reduce your costs!

To do this—you need *accurate weight-control* every step of the way! Toledo has the broad engineering experience and the world's most complete line of scales to fit your requirements . . . in weighing, counting, force-measuring, batching or testing. Look to Toledo! Toledo Scale Company, Toledo 12, Ohio.

TOLEDO

HEADQUARTERS FOR SCALES

TIGHT VALVES

SPEED PRODUCTION

...LOWER COSTS

LUNKENHEIMER VALVES
STAY TIGHT WITH LESS CARE

No business can afford wasteful, costly, production-lowering valve leakage. That's why it's always *good* business to maintain a regular check on valves to make sure they are *tight* and in proper working order.... Maintenance men the nation over prefer Lunkenheimer Valves. They know from experience that these *quality-built* valves serve longer and better on the job—are easier to keep tight with a minimum of time, labor, and expense.

ESTABLISHED 1862

THE LUNKENHEIMER CO.

"QUALITY"

CINCINNATI 14, OHIO. U. S. A.

Fig. 153 "N-M-D" Globe (Non-Metallic Disc)
Fig. 2125 Bronze Gate
Fig. 14 "Renewo" Globe
Fig. 1640 "King Clip" Gate
Fig. 1430 Iron Body Gate

See Your
LUNKENHEIMER DISTRIBUTOR
for Better Valve Service

Lunkenheimer Distributors are located in principal industrial centers. There is one near you, fully equipped and ready at all times to assist with your valve maintenance, repair and operation (MRO) problems. Call on him! Ask for Lunkenheimer chart showing costs of air, steam and water valve leakage.

LUNKENHEIMER VALVES

BRONZE, IRON, STEEL AND CORROSION RESISTANT ALLOY VALVES, 125 TO 2500 LB. S. P.; BOILER MOUNTINGS, LUBRICATING DEVICES, AIRCRAFT FITTINGS

• Keep Informed

The vertical deflection or Y-axis provides any degree of attenuation between 1:1 and 1000:1; great expansion of negative polarity signal; undistorted deflection of at least 2"; and frequency response within 3 db. from 10 cps to 10 mc. The X-axis or horizontal deflection functions with a sawtooth time-base generator of the driven type, variable from 1 to 15,000 microseconds and with a horizontal deflection of at least 4 inches. The time base can correspond with any horizontal line in either or both of the interlaced fields. This is the "line-selecting" feature which makes this instrument unique, invaluable and indeed a "must" for the television broadcast studio and the research laboratory for determining the character of the picture-signal video in conjunction with transmitter operation and in accordance with FCC standards and practices, and also for industrial uses for certain types of high-speed, single-transient studies.

Two methods for the accurate measurement of time intervals are incorporated in the Type 280. The first consists of calibrating the length of the sweep with the writing-rate calibrator. This is particularly valuable in the measurement of time intervals smaller than about 5 microseconds. The second method consists of using the calibrated delay. This is particularly useful on time intervals longer than 4 microseconds. The operation of external apparatus may be initiated or synchronized from the delayed trigger output of the instrument, with the calibrated delay range of from minus 25 to plus 1000 microseconds. The negative delay feature is useful for many applications.

The calibrating generator included in this instrument serves to calibrate sweep-writing speeds by signals of 10, 1, and 0.2 microseconds. The instrument provides for a wide range of sweep-writing speeds and for continuous variation between 0.25 microsecond/inch and 3000 microsecond/inch, while delay ranges of 100 or 1000 microseconds may be selected for the linear time-base. There is an indication as to exact occurrence of time-base with respect to the overall television picture. The interval of 0.25 microsecond may be measured to plus/minus 0.01 microsecond.

A picture monitor is not included in the Type 280 since one or more of these units are usually available in studio and transmitter equipments. If a monitor is necessary but not already at hand, the Du Mont Type 311 cathode-ray oscillograph may be used. This contains all the units comprising Type 280, plus a 7-inch cathode-ray tube and associated circuits to perform the monitoring function. This tube and circuits form a unit which can be fitted on top of the relay rack holding the four units of Type 280.

Type 280 operates on the usual 115-volt 50–60 cycle A.C. supply, and consumes 690 watts.

• BUSINESS CHANGES

Hannifin Corporation

The Hannifin Manufacturing Co. of Chicago, announces that it has changed its corporate style to the Hannifin Corp. Also with the completion of a new office addition to the main Chicago Plant, the general offices have been moved from 621 South Kolmar Avenue to 1101 South Kilbourne Avenue.

It is announced that Ellwood G. Peterson, formerly Vice-Pres. and General Manager, has been elected President, Mark R. Gault, Controller, was elected Sec'y, and Vice Presidents Harry H. Adams, Otto J. Maha and Clarence B. Mitchell were reelected.

• Keep Informed

Bridgman Castings, Inc., Bridgman, Michigan, a subsidiary of the Hannifin Corp., announces that Harry E. Davies, formerly a Hannifin Factory Manager, has become the Manager at Bridgman and was elected a Vice President.

New Truarc Sales Manager Appointed

Harold F. Bower, formerly in charge of the Truarc Technical Service Staff, has been named Sales Manager, Truarc Retaining Rings Division, Waldes Kohinoor, Inc., Long Island City, N. Y.

Mr. Bower is a graduate of mechanical and electrical engineering, Cornell University, class of 1922. Under his direction the facilities of the Truarc Sales Department will be enlarged to permit a more integrated selling and technical program.

Carl G. Nordmark Joins Lord Manufacturing Co.

The Lord Manufacturing Co. of Erie, Pa., announce the establishment of a new Advertising Division and the appointment of Carl G. Nordmark as Supervisor of Advertising. Until recently Mr. Nordmark was Assistant Publicity Manager of the Heald Machine Co. of Worcester, Mass. and comes to Lord with over ten years' background in industrial advertising.

Kennametal Inc. Opens District Office in Buffalo

Kennametal Inc., Latrobe, Pa., manufacturer of cemented carbide tools, announces the opening of an office at 528 White Building, Buffalo, N. Y. Mr. Harry W. Bearfoot has been transferred from Pittsburgh to Buffalo where he will serve as tool engineer and representative.

Rollway Bearing Opens Pittsburgh Office

A new sales office of Rollway Bearing Co., Inc., Syracuse, N. Y. has been opened in Pittsburgh, with John B. Bell, Rollway's sales representative, in charge. Address of the new office is Room 507, Renshaw Building, 9th Street at Liberty, Pittsburgh, Pa.

Mr. Bell, who for several years has served as sales representative with headquarters at the Syracuse home office, started his new assignment April 15, it was announced by H. A. Pierce, Sales Manager.

• LATEST CATALOGS

Recording and Controlling Instruments

A new bulletin listing over 150 different items maintained in stock for immediate delivery has been published by The Bristol Co., manufacturers of recording and controlling instruments for industrial processes. The new bulletin #41811 lists recording thermometers, pyrometers, pressure gauges, voltmeters, ammeters, and pH recorders. Also listed are recording controllers, indicating controllers, miscellaneous instruments, and accessories.

Copies of Stock Instruments Bulletin #1811 are available from The Bristol Co. at Waterbury 91, Conn.

Corrosion Data Charts

16-page booklet in three colors. Features complete corrosion data charts of the resistance values of the alloys and metals most commonly used for tank construction. The properties are given in terms of ratings at various temperatures and concentrations of salts, acids and miscellaneous substances. In addition many examples of sheet and

Continued on Page 48

Photo courtesy o Dumore Co., Racine, Wis.

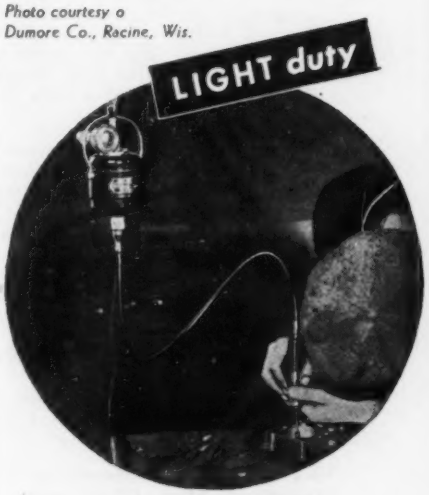


Photo courtesy of General Gas Light Co., Kalamazoo, Mich.

S.S.WHITE

FLEXIBLE SHAFTS

make it easier to do the job

In the small portable tool (left above) the flexible shaft makes possible a small, light hand piece. This means a tool that can be manipulated freely, accurately. and delicately with a minimum of fatigue.

In the heavy duty drill press (right above) the flexible shaft spindles make possible quick changes in setup for different drilling requirements. They provide positive, reliable drives and give the machine time and cost-saving versatility.

GET THIS FLEXIBLE SHAFT HANDBOOK

This 260 page handbook gives full information and engineering data about flexible shafts and their application. A free copy will be mailed on request if you write for it on your business letterhead and mention your position.

S.S.WHITE INDUSTRIAL DIVISION

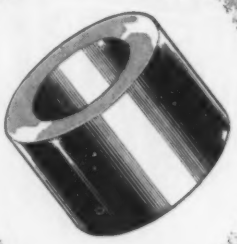
THE S. S. WHITE DENTAL MFG. CO.

DEPT. L, 10 EAST 40th ST., NEW YORK 16, N. Y.

FLEXIBLE SHAFTS • FLEXIBLE SHAFT TOOLS • AIRCRAFT ACCESSORIES
SMALL CUTTING AND GRINDING TOOLS • SPECIAL FORMULA RUBBERS
MOLDED RESISTORS • PLASTIC SPECIALTIES • CONTRACT PLASTICS MOLDING

One of America's AAAA Industrial Enterprises

WORKS WHERE OTHERS WON'T



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GRAPHALLOY OILLESS BEARINGS

SPECIFY GRAPHALLOY WITH CONFIDENCE

SELF-LUBRICATING ● EXTREMELY DURABLE ● CONSTANT CO-EFFICIENT OF FRICTION ● OPERATES DRY — OR SUBMERGED IN WATER, GASOLINE OR CORROSIVE LIQUIDS ● APPLICABLE OVER A WIDE TEMPERATURE RANGE — even where oil solidifies or carbonizes ● EXCELLENT AS A CURRENT-CARRYING BEARING.

GRAPHITE METALLIZING CORPORATION

1058 NEPPERHAN AVENUE, YONKERS 3, NEW YORK

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clad fabrication in steel, stainless steel, nickel, copper, aluminum and alloys are shown, as well as Nooter metallizing methods and their applications. For free copies of corrosion data charts write John Nooter Boiler Works Co., 1432 South 2nd. St., St. Louis 4, Mo.

Roto-Clone Dynamic Precipitator

A new 19-page illustrated booklet covering the American Air Filter Co.'s Type D Roto-Clone dynamic precipitator, a device particularly adapted to the dry collection of practically every type of granular industrial dust. Among the many illustrations are detailed views of Wear Liners, Radiation Shield, Skimmer Precleaners, Aftercleaners, Rotary Locks, Trickle Valves and Models E & F Self-Contained units together with capacity and dimension table for each size.

Issued free upon request, write American Air Filter Co., Inc., 215 Central Ave., Louisville 8, Ky.

Free Pamphlet on Storage of Microfilms, Sheet Films, and Prints, Offered by Kodak

To aid business and industrial organizations, as well as photographic concerns, to solve the problems connected with the storage of photographic films and prints, the Eastman Kodak Co. has issued a new, free pamphlet titled, "Storage of Microfilms, Sheet Films, and Prints."

Intended to serve as a guide to those who desire to store safety film base and paper base materials only—nitrate films are not covered—the pamphlet discusses the protection required, classification of records, short term storage, archival storage, moderate-term storage, preparation for storage, fire protection, storage relative humidity, storage temperature, and methods of testing the film and papers for hypo elimination.

All suggestions and recommendations in the text are based on extensive laboratory tests and years of experience, and are made with the desire to help preserve valuable photographic records so that they will not only be readily available but also maintained in the best possible condition.

The pamphlet, "Storage of Microfilms, Sheet Films, and Prints," may be obtained without charge by writing Sales Service Division, Eastman Kodak Co., Rochester 4, N. Y.

Products for Heating, Ventilating and Air Conditioning

Allis-Chalmers products for heating, ventilating and air conditioning, which are used in a variety of installations from department stores and office buildings to aviation wind tunnel testing, are presented in a new bulletin released by the company.

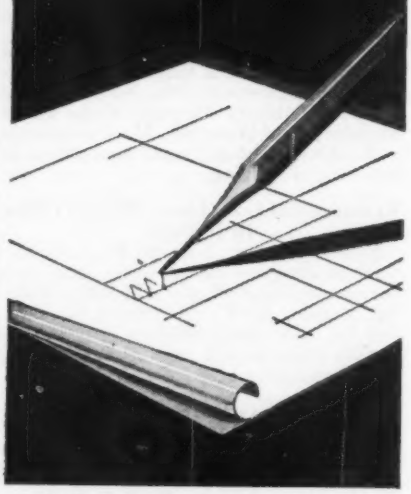
Equipment portrayed and described includes Texrope V-belt drives, centrifugal pumps, a-c and d-c motors, a complete line of motor control, dry-type transformers and a-c and d-c welders.

The 12-page bulletin, 25B6183, is available upon request from the Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.

More than 18,000 Copies of Flow Meter Handbook Sold

A recent order received by The Foxboro Co., 182 Neponset St., Foxboro, Mass., marked the sale of the 18,000th copy of "Principles and Practice of Flow Meter Engineering." This handbook, which has now virtually attained the rank of a classic, is widely used in every industrial field, and its distribution reaches to the farthest corners of the globe. It is the constant companion of operating men in the field; it is used as a textbook in engineering schools.

TRACING CLOTH for HARD PENCILS



● Imperial Pencil Tracing Cloth has the same superbly uniform cloth foundation and transparency as the world famous Imperial Tracing Cloth. But it is distinguished by its special dull drawing surface, on which hard pencils can be used, giving clean, sharp, opaque, non-smudging lines.

Erasures are made easily, without damage. It gives sharp, contrasting prints of the finest lines. It resists the effects of time and wear, and does not become brittle or opaque.

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IMPERIAL PENCIL TRACING CLOTH

SOLD BY LEADING STATIONERY AND DRAWING MATERIAL DEALERS EVERYWHERE.

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Apparatus manufacturers whose flow problems affect the design and performance of their equipment regard the handbook as an essential every-day tool.

The first Foxboro flow meter handbook, "The Orifice Meter," was published in 1921, in the days when information for calculating orifice coefficients was considered a trade secret, to be sold with the meter. The book, which gave the public its first fully correlated data for performing all necessary orifice meter calculations, made of the industrial world one huge laboratory, with meter-users everywhere helping to check the accuracy of results.

Based on thousands of reports from users, many changes and improvements have been made in the 25 years since Foxboro first made this flow meter data conveniently available. On the basis of these time-tested results, The Foxboro Co. feels that the information presented in the current (sixth) edition of "Principles and Practice of Flow Meter Engineering" can be recommended without qualification.

Process Equipment

General American Transportation Corp., Sharon, Pa., has issued a 20-page bulletin describing a wide variety of process equipment as well as tanks, vapor seals, floating roofs, bins and stacks, and various other units employing steel and alloy plate fabrication. Process Equipment covered in this comprehensive bulletin include Rotary Kilns Coolers, and Dryers, Louisville Rotary Dryers, Peterson and Conkey Filters, Conkey Evaporators, Turbo-Mixers and Thickeners. All of the various units described in this book are, in most cases, shown in actual photographs.

"Learning to Weld"

"Learning to Weld," provides a simple basic approach for anyone interested in making a start in arc welding. The booklet's purpose is to teach now to weld and to assist in applying arc welding to the repair of broken parts, the hard surfacing of worn parts and the building of miscellaneous equipment. From the information contained in the booklet, the person interested in arc welding gains clear insight into important aspects of the subject on which he may add further knowledge as he desires.

Subjects treated include the following: protective clothing and equipment; striking the arc; various welding positions; types of welds; fit-up of parts; procedures for various welds including fillets in horizontal, flat, vertical and overhead positions, butt welds, lap welds, corner and edge welds; welding cast iron; hard surfacing.

There are four pages containing 22 illustrations of typical applications of arc welding in repair and construction. Also included are conversion tables on decimal equivalents and thicknesses of metal in both gauge and inches. There is also a glossary of welding terms.

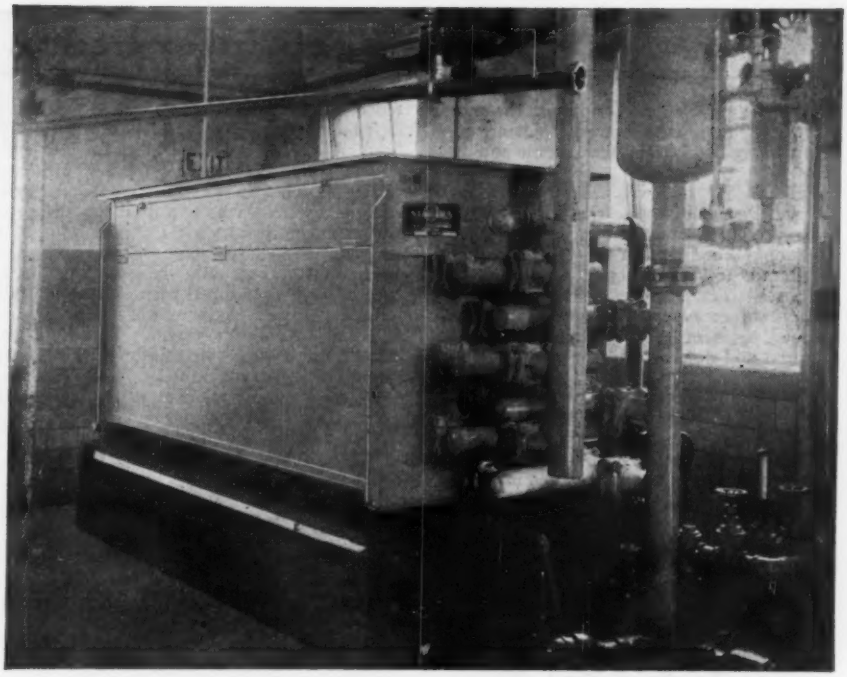
"Learning to Weld," published by The Lincoln Electric Co., Cleveland, Ohio, 32 pages, 5-1/2" × 8-1/2", 83 illustrations including photos and drawings, bound in good quality paper cover, price postpaid anywhere in U.S.A. 25¢ per copy, elsewhere 35¢ per copy.

New Falk Coupling Bulletin Features New Method of Selection

Milwaukee, Wis. Selection of just the right coupling for the job is a simple matter when you have the new Bulletin 4100 on Falk Steelflex Couplings just issued by The Falk Corp., Milwaukee 8, Wis.

In addition to giving detailed illustrations and descriptions of the new and improved

Continued on Page 50



NIAGARA LIQUID COOLER
Gives High Capacity in Small Space

Cold water, chilled to 33° F., or cold liquids, or non-freezing solutions below 32° F. are produced economically by the new Niagara Liquid Cooler.

For large capacity equipment it is most compact. For example, one model furnishes 92 gallons per minute of water cooled from 45° F. to 35° F., with 28° F. refrigerant temperature, in less than 30 sq. ft. of floor space. Other models . . . from 24 to 465 G. P. M.

Extra advantages are positive temperature control; assurance of holding temperature accurately in spite of variation in cooling load; rapid chilling of the liquid; savings in power and refrigeration consumption.

Write for Bulletin No. 100-ME.

NIAGARA BLOWER COMPANY

Over 30 Years' Experience in Industrial Air Engineering

405 Lexington Ave. NEW YORK 17, N. Y.

Field Engineering Offices in Principal Cities

INDUSTRIAL COOLING HEATING • DRYING

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HUMIDIFYING • AIR ENGINEERING EQUIPMENT

Falk Type F Steelflex Couplings, the most complete, simplified selection tables are improvided for both motor and turbine applications.

Falk's new standardization which results in a wider range of application for one standard type of Steelflex Coupling, plus the new selection method used in this bulletin, makes for greater accuracy in selection and simplified installation.

Eight other types of Falk Couplings developed to meet special purposes are also pictured and described in the new booklet.

New Bulletin Describes G-E Inkless Temperature Recorder

A new eight-page, two-color bulletin (GEA-4572) describes the Type CF-2 inkless temperature recorder recently announced by General Electric. Various industrial applications for the new unit, such as recording temperatures in generators, transformers, ovens, air ducts, etc., are listed, along with complete specifications. Accessories, such as a test resistor, and resistance-temperature detectors used with the unit, are pictured and described.

New South Bend Lathe Catalog No. 13-F

This new South Bend Lathe catalog, just off the press, illustrates in full color and completely describes the 13-inch swing South Bend Quick Change Gear and Toolroom Lathes. Attachments and accessories are also shown.

The 13-inch South Bend Lathe features a quick change gear box which makes immediately available gear combinations for cutting 48 pitches of screw threads, right- or left-hand, and 48 power longitudinal feeds and cross-feeds. The various gear box lever settings are easily selected from an attached direct reading index chart. Also featured on the 13-inch lathe is a double wall apron which is equipped with a friction clutch to operate the power longitudinal feeds and cross-feeds. The lathe headstock is back-geared and is equipped with a super-finished spindle, adjustable precision bearings, and an efficient oiling system. The fully enclosed motor drive provides eight headstock spindle speeds ranging from 34 to 875 r.p.m.

A copy of Catalog No. 13-F may be obtained by writing to the South Bend Lathe Works, 385 E. Madison St., South Bend 22, Ind.

KleenKut Water-Mix Cutting Oil

A new four-page folder describing KleenKut, a laboratory controlled water-mix cutting oil, has recently been published by the D. A. Stuart Oil Co. The folder describes typical applications of KleenKut and the proper method for mixing with water.

Free copies are available upon request. Write to D. A. Stuart Oil Co., Ltd., 2741 South Troy Street, Chicago 23, Ill.

Maxitorq Machine Tool Clutches

The Carlyle Johnson Machine, Co., Manchester, Conn., announces a new Catalog covering the Maxitorq Floating Disc Clutch and the Maxitorq Automatic Overload Release Clutch . . . together with Ring Type Driving Cups.

The Standard Maxitorq is available up to 15 H.P. at 100 R.P.M.; the Overload up to 5 H.P. Both clutches have patented features such as Separator Springs which keep the discs "floating" in neutral . . . "you can see between them"; and both may be assembled, adjusted and taken completely apart without the use of tools. Complete engineering data is shown in specification tables and diagrams.

This organization, making nothing but clutches for 40 years, has enjoyed its largest volume of business in 1946 and has greatly increased its facilities in 1947.

Catalog may be obtained by writing to them at the above address.

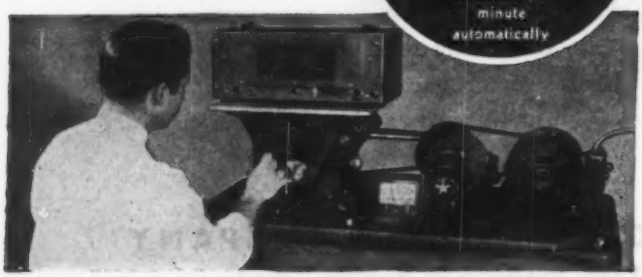
Blueprinting and Whiteprinting Machines and Accessories

The new Pease General Catalog (tenth edition) is a handsomely bound 238-page book containing information on the company's line of blueprinting machines and accessories, whiteprinting (dry direct process) machines and accessories, sensitized papers and cloths, drafting room furniture and photographic arc lamps. Equipment described covers a wide range of drafting room needs. The book is comprehensively illustrated with more than 150 large clear illustrations, including full-view, cutaway and close-up illustrations, as well as diagrams. Pages are devoted to descriptions of applications and detailed information regarding measurements and weights of equipment. The book is conveniently divided into seven sections and is thoroughly indexed. Copy may be had by writing a request on your letterhead addressed to The C. F. Pease Co., 2623 West Irving Park Road, Chicago 18, Ill.

All-American VIBRATION Fatigue Testing

SHOWING MODEL 100VA VERTICAL ACTION 600 to 3,300 vibrations per minute automatically

Basic testing . . . spotting the "bugs" of stress and strain . . . fosters bettered products and lowered costs in your new postwar lines. All-Americans have uniform acceleration-deceleration, besides control at fixed cycles of vibration. An inspection and research favorite. Write for Catalog F.



10 to 55 cycles per second, automatic with automatic acceleration and deceleration. 10 to 60 cps, manually.

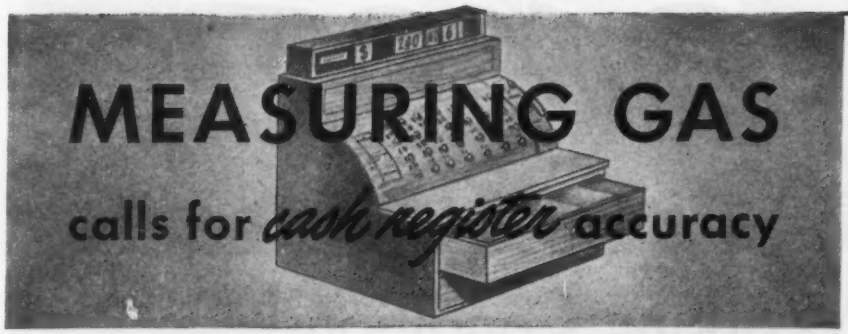
Load capacity 100 lbs., other models 10 and 25 lbs. capacity. 8 models to choose from. Quick delivery!

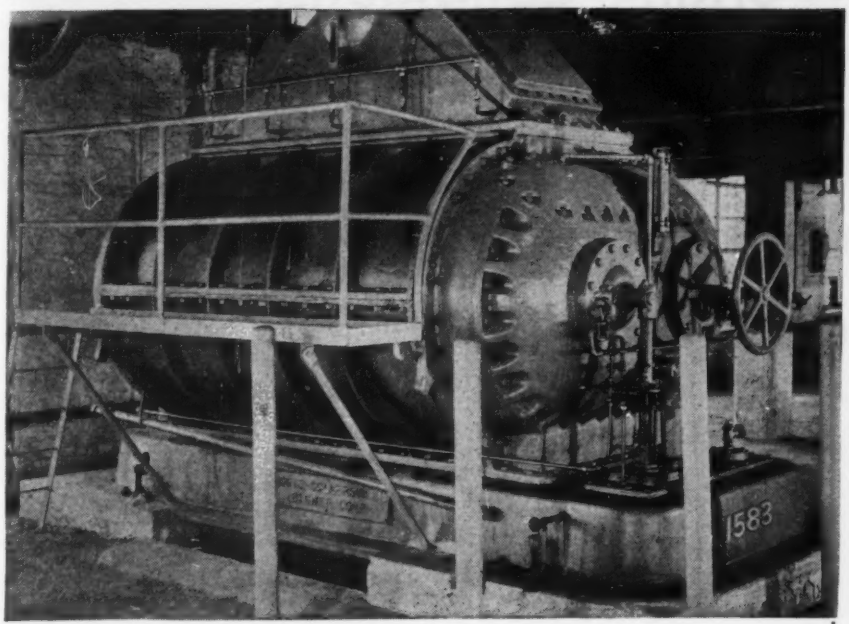
ALL AMERICAN
Tool & Manufacturing Co.
1014 Fullerton Ave., Chicago (14)

NO OTHER PUMPS FIT THE JOB LIKE TUTHILL STRIPPED PUMPS

Tuthill Stripped Pumps are designed for building directly into machines to save space, improve appearance and reduce costs. Two types available: Type S, furnished without mounting bracket; and Type SA which provides pumping elements only. Ideal for lubrication, coolant, hydraulic and liquid transfer service. Capacities up to 200 g.p.m. Write for Tuthill Stripped Pump Bulletin.

TUTHILL PUMP COMPANY
939 East 95th Street • Chicago 19, Illinois





You'll get just that kind of accurate measurement with Roots-Connersville Positive Displacement Meters. That's because:

1. Accuracy is not affected by variations in specific gravity, rate of flow, pulsation, moisture or impurities.
2. Accuracy does not depend on uncontrollable factors.
3. Accuracy is not subject to adjustment of meter or recorder by operators.
4. Accuracy is not affected by reasonable overloads.
5. Accuracy is permanent because measuring chambers are surrounded by precision-machined cast-iron surfaces.

Other advantages of R-C Meters include: negligible operating cost, small space requirements and continuous, dependable performance.

For accurately measuring production, consumption or delivery of gas and for interdepartmental accounting, you can count on the cash-register accuracy of Roots-Connersville Positive Displacement Meters. For detailed data, ask for Bulletin 40-B-14—free, of course.

ROOTS-CONNERSVILLE BLOWER CORPORATION
705 Michigan Ave., Connersville, Indiana

ROOTS-CONNERSVILLE ROTARY CENTRIFUGAL
BLOWER BUILDERS R-C SINCE 1854
BLOWERS • EXHAUSTERS • BOOSTERS • LIQUID AND VACUUM PUMPS • METERS • INERT GAS GENERATORS

★ ★ ONE OF THE DRESSER INDUSTRIES ★ ★

LET
R-C dual-ability
PLAN YOUR BLOWERS

If your business calls for moving gas or air at moderate pressures, we can plan and supply your equipment. Many sizes and types of standard units are available. For special applications, our engineers are alert to every means of giving you the best results for the money invested.

Centrifugal Blowers and Exhausters, in single or multi-stage units, are built for capacities up to 50,000 CFM or higher.

Rotary Positive Blowers are available in capacities from 10 CFM up. Simple design and construction free them from maintenance troubles. Many types and sizes are available for built-in or separate applications.

Rotary Positive Gas Pumps are widely used in handling of CO_2, SO_2 and other gases, both natural and manufactured. Capacities from 10 to 50,000 CFM.

Positive Displacement Meters for accurately measuring gas or air. Fitted with many types of recording instruments. Capacities from 1,000 to 1,000,000 CFH.

Inert Gas Generators are the safe answer to hazards of explosion or fire where inflammable gases or liquids are stored or handled.

For additional information on any Roots-Connersville equipment, write us your problems or send for individual bulletins.

MAIL THIS COUPON WITH YOUR LETTERHEAD

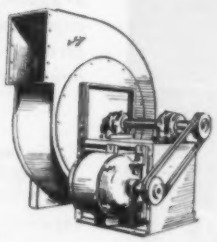
Roots-Connersville Blower Corporation,
705 Michigan Avenue
Connersville, Indiana
Please send information on:

BLOWERS_____ EXHAUSTERS_____
VACUUM PUMPS_____ METERS_____
BOOSTERS_____ LIQUID PUMPS_____
INERT GAS GENERATORS_____
NAME_____
TITLE_____

CONTROL DUST TO

1 Improve Working Conditions!

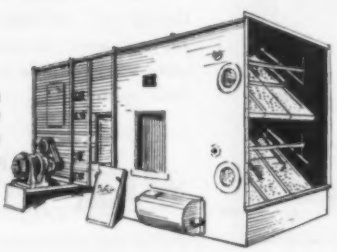
"Buffalo"
EXHAUST FANS
These new highly efficient exhausters have smooth, all-welded housings. Bulletin 3576.



Control of dust in your plant or shop can make a big difference in working conditions! "Buffalo" Exhausters remove harmful dust, fumes, abrasives, etc., from the air—cut employee sickness and absenteeism to a minimum. "Buffalo" Exhausters require very little maintenance and make your power dollars go much farther.

2 Raise Product Quality!

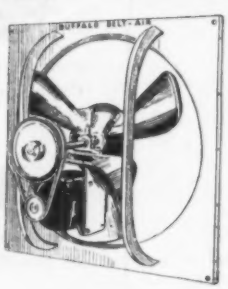
"Buffalo" WET GLASS CELL AIR WASHERS
These units wash the air and filter it through spun-glass filters . . . removing over 98% of the dust. Bulletin 3457.



When your product must be kept free of air impurities, many manufacturers have found that "Buffalo" Wet Glass Cell Air Washers play a big part in maintaining uniform high quality. Besides keeping atmosphere free of practically all dust, these units can also provide humidification, cooling or heating, as desired . . . for further control of your product quality. For complete facts, write for Bulletin 3457.

3 Increase Production!

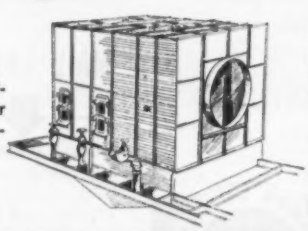
"Buffalo"
DISC FANS
Available in belted or direct motor drive, "Buffalo" Breezo and Belt-Air Fans operate quietly and at negligible cost. Bulletin 3222-D.



Many a ventilation system has its smoky, dead air spots . . . where production lags! Workers can't do their best in a stifling atmosphere. By spotting "Buffalo" disc-type fans in these areas, you can bring live, fresh air to every worker very economically . . . clear the air of dust and fumes . . . and step up production. These "Buffalo" Fans are easily mounted on outside walls, where they do a steady, thorough job of drawing the bad air OUT. You'll find complete facts in Bulletin 3222-D. Write for it, for your files.

4 Salvage Dust!

"Buffalo"
AIR WASHERS
These air washers are available in several types, for collecting valuable or dangerous dusts.

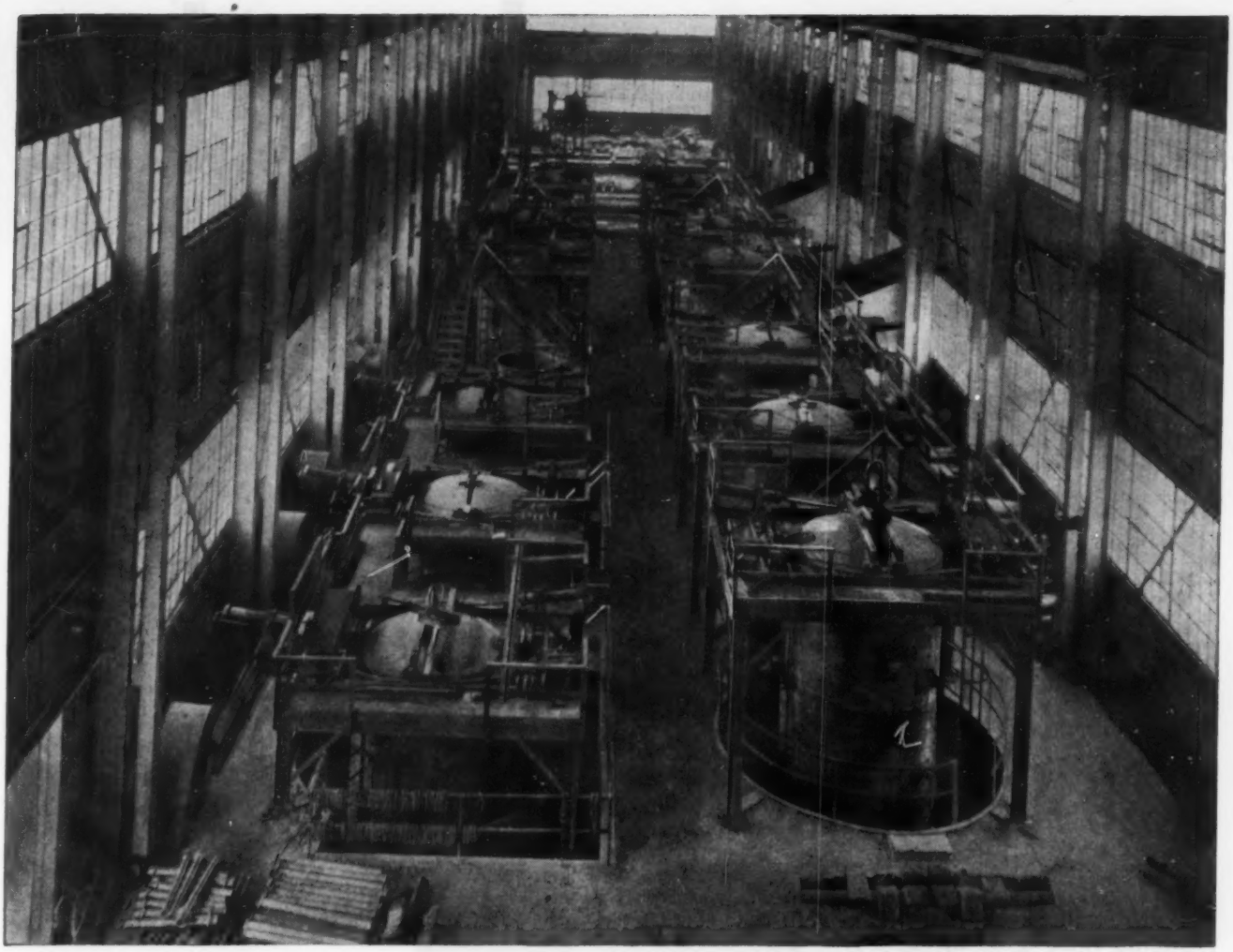


Many industrial processes require thorough recovery of valuable by-product material in dust form. Here, you will find Buffalo Type "DE" and "TE" Static Washers the low-cost answer. Extra sets of scrubbing plates insure complete collection, in a settling tank, either manually or automatically flushed out. Facts on the several models will be found in Bulletin 3142-C. Write for your copy!

BUFFALO FORGE COMPANY **148 MORTIMER STREET, BUFFALO, N. Y.**
Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

"Buffalo"

Equipment For Dust Collection



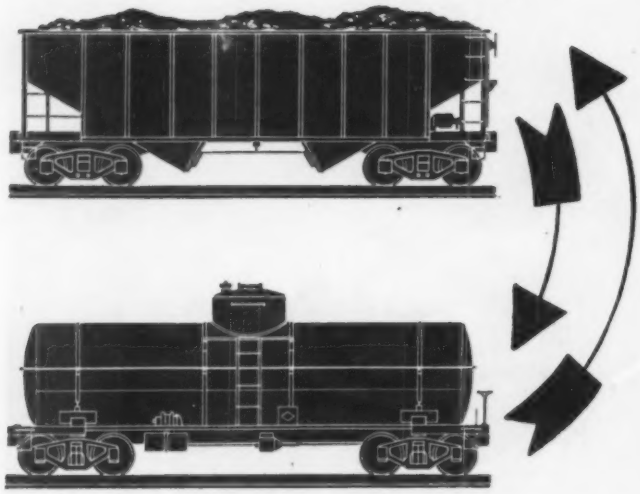
the Heat Treating factor in "OK" steel forgings

● The heat treatment factor in steel forgings has become a necessary part of steel forging specifications. This is particularly true of alloy steels where only by correct heat treatment can the full value of the alloys be realized in the finished forging.

National Forge has long been aware of this important factor and thus is set up to provide in its forgings the qualities that only correct heat treating can impart. It has both vertical and horizontal furnaces and adequate controls throughout the heat treating processes to insure the desired results.

There are many variables involved in heat treating which demand careful adherence to treating procedures. National Forge through its years of experience has well established procedures which attain correct results. For heat treated forgings consult first with National Forge.

National Forge
AND ORDNANCE COMPANY
Irvine, Warren County, Pennsylvania



changing fuels IN YOUR POWER PLANT?

It's No Problem to users of ENCO OIL BURNERS with COAL FIRED UNITS

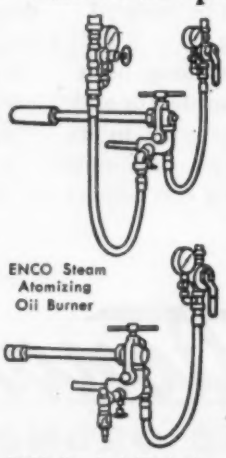
Coal—oil—or both if necessary; changing fuels is no problem if your power plant is equipped with ENCO Oil Burners in combination with coal burning units. Your operations need only be governed by availability of fuels and comparative BTU costs.

from coal to oil and back to coal if necessary!

ENCO Burners, designed for use with or without air registers and for natural or forced draft, are made in various sizes with capacities from 10 to 1,000 gallons per hour. Mechanical and steam atomizers may be used interchangeably to provide a wide load range from cold starting to full load operation.

With Pulverized Coal Burners either ENCO Mechanical or Steam Atomizers are used for ignition and entire load range. Bulletin OB-PC, giving complete details on use of ENCO Oil Burners with pulverized coal will be sent on request.

With Stoker or Hand-Fired Units, this same combination of oil burners with coal fired units can be used with either Steam or Mechanical Atomizer for partial or full loads. Complete information on either temporary or permanent installations of this type will be sent on request.



ENCO Steam Atomizing Oil Burner

ENCO Standard (Mechanical Atomizing) Oil Burner

EC-465

THE ENGINEER COMPANY

Also Produces

Enco Streamline Baffles
Enco Oil and Gas Burning Equipment
Enco Fuel Oil Pumping and Heating Units
Enco Automatic Combustion Control

THE ENGINEER COMPANY

75 West Street, New York 6, N. Y.
Canadian Representative
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We Like Tough Jobs!

TAKE A LOOK AT THE McDONNELL PHANTOM

FOR INSTANCE

PHANTOM
IN THE ENGINES THAT POWER IT
FooteBros. produces this accessory drive for the turbo-jet engines which provide power to operate pumps, starter motors, generators and other equipment.
IN THE SPEED BRAKE THAT GIVES CONTROL
Tremendous speed demands split second control. Positive operation of the speed brake is provided by this assembly.

HERE'S the fastest thing with wings that ever took off from an aircraft carrier's flight deck—the McDonnell Phantom!

Powered by two turbo-jet engines—streamlined to achieve a top flight speed of over 500 miles per hour—it still has the stability and control characteristics at slow landing speeds comparable to conventional carrier-based planes.

This is another major development in modern aircraft in which Foote Bros. "A-Q" Gears and Power Units are playing a part.

On the axial flow turbo-jet engines the accessory drive units are produced by Foote Bros. In the wings of the Phantom, Foote Bros. actuators supply immediate response in raising and lowering speed brakes—so important in the control of this swift plane.

Manufacturers of many types of industrial equipment requiring gears of extreme precision are finding in Foote Bros. "A-Q" (aircraft quality) Gears an answer to problems of greater efficiency, higher speed, unusual compactness, light weight and low noise level.

Manufacturers of equipment requiring absolute control of operations from a remote point may find an answer in Foote Bros. Power Units and Actuators. These units are individually engineered to the job they are intended to do, and assure compactness, light weight, and, above all, positive control of linear or rotary motion within an exact time cycle. They also provide the extremely accurate mounting of "A-Q" Gears—so essential if the full benefit of their precision is to be realized.

Of course, you as well as thousands of other leading manufacturers will continue to look to Foote Bros. for industrial gears of all sizes and types and speed reducers in a wide range of ratios as you have since 1859.

Two engineering bulletins, one on "A-Q" gears, the other on Power Unit, offer many suggestions on new developments in application of power. If you have not received copies, mail the coupon below.

FOOTE BROS.

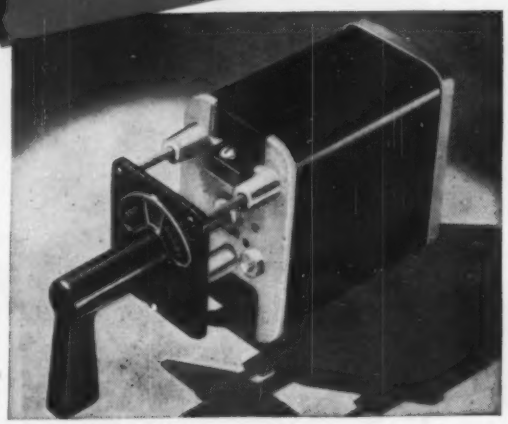
Better Power Transmission Through Better Gears

FOOTE BROS. GEAR AND MACHINE CORPORATION
4545 South Western Boulevard • Chicago 9, Illinois

FOOTE BROS. GEAR AND MACHINE CORPORATION
Dept. Q, 4545 S. Western Blvd., Chicago 9, Ill.
Gentlemen: Please send me Bulletins on:
☐ Power Units ☐ Aircraft Quality Gears

Name.....
Firm.....
Address.....
City.....State.....

DESIGNER'S *Digest*



ONE SWITCH

...with more than 7000 uses

For applications up to 600 volts, 20 amperes — from ON-OFF to complicated-sequence switching — you can get an "exactly right" switch for any application, easily, quickly and economically.

Imagine a control and transfer switch made up of standard parts, yet so flexible in its application that designers have used it in more than 7000 different arrangements! That's the G-E Type SB-1 switch.

For ordinary control jobs, you specify the ordinary type. On highly specialized applications, you still benefit from standardization. By using *standard* cams, contacts, fingers and other parts, we build you a "custom-made" switch to control practically any sequence of operations *and* at the price of a standard unit.

G-E control and transfer switches are designed and built for extra reliability and long service life. Important construction features are silver-to-silver contacts, anti-arcing barriers between adjacent circuits, sturdy Textolite face plates, and attractive switch handles. For complete details and contact possibilities, check Bulletin GEA-1631E.

Pick the contact type you need

Single-break contact	*for*	simple control arrangements, also staggered contact arrangements.
Two single-break contacts, center connection	*for*	single-pole, double-throw arrangements.
Two single-break contacts, in series	*for*	single-pole, single-throw with double-break interrupting capacity.
Two single-break contacts, separate connections	*for*	two-pole, single-throw arrangements.
Three single-break contacts, common connection	*for*	opening and closing a device with one circuit.

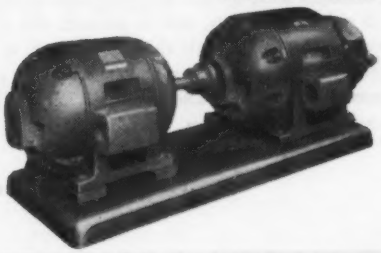
For Extra Heavy Duty Service!

When you need a control switch to perform many thousands of repetitive operations per week, use a unit that has extra strength "built in" — G. E.'s master control switch, Type SB-9. Steel mills like the way it stands up to heavy circuit control jobs. Every part — contacts, gears, shunt connections, even handles are made extra strong to resist wear. Ask for Bulletin GEA-4114.

GENERAL ELECTRIC

High Speeds...

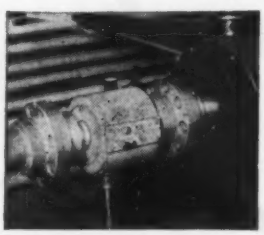
MADE EASY!



Many grinding and woodworking machines, as well as portable hand tools, have high-speed motors which require frequencies above the regular power supply. G-E induction frequency converters will supply 120, 180, 240, 360 and 420 cycles for these jobs. The converter is designed for constant excitation from a polyphase a-c supply and may be furnished alone or in combination with a driving motor. Ask your nearest G-E office for further information on induction frequency converters or frequency converter sets.

Tells pound-feet...

WITHOUT CRADLING!



This G-E electromagnetic torque meter is surprisingly easy to use. You simply couple the shaft unit between the load and the driving unit, start the machine, and take your readings. Cradling the load or fussing with scales is unnecessary. The meter measures torque directly without absorbing power from the load. This instrument consists of a shaft unit, oscillator, power unit, and indicating devices. Absolute accuracy within plus or minus 1 per cent of full-scale reading is provided. Check Bulletin GEA-4441A on coupon.

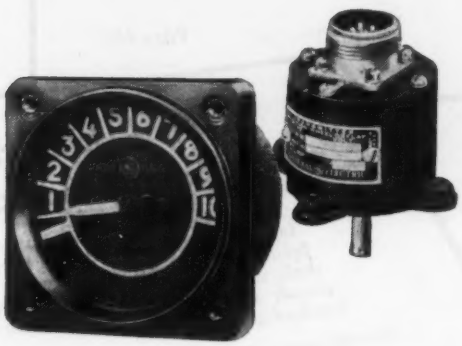
Better Welders...

TRAINED FASTER!

The war years proved the value of visual employee training methods. Output climbed, rejects dropped. Now G. E. has produced a new full-color sound movie that illustrates by animated sketches the principles and uses of three types of resistance welding — spot, projection, and seam. More than 100 applications are shown in fifteen different industrial plants. Accompanying the film is an interesting bulletin which reiterates the key points made in the film. The film, part of G.E.'s MORE POWER TO AMERICA program, is available for loan without charge from your local G-E office.

POSITIONS MADE CLEAR

...from remote stations!



Thousands of military aircraft found one or more uses for G-E position-indicating equipment. Many of the jobs called for high accuracy and complete reliability in remote transmission of position signals. Now G. E. believes that industrial designers can take advantage of this wartime development. To that end, our engineers are ready to help you investigate application possibilities on your machines, large or small.

One of the new position-indicating arrangements perfected by G. E. is a d-c selsyn three-wire system. Transmitters will operate in an ambient temperature range from —85 F to 158 F and are weather resistant. Indicating instruments are available in two standard sizes — 1⅞-inch dial with 1 or 2 pointers and 2¾-inch dial with 1, 2, 3, or 4 pointers. Dial markings are made to meet your requirements.

A single d-c selsyn indicating system consumes about 2 watts at either 12 or 24 volts. Any reasonable lead length may be used. Two indicating instruments can be operated from the same transmitter. Bulletin GET-1304 is a comprehensive application manual you'll find extremely helpful. Check it on the coupon.

TO GENERAL ELECTRIC COMPANY
Section D668-54, Schenectady 5, N. Y.
Please send me the following information:

_____GEA-1631E (Control and transfer switches)
_____GEA-4441A (Torque meter)
_____GEA-4114 (Master control switches)
_____GET-1304 (Position-indicating system manual)

Name _____
Company _____
Street _____
City _____ State _____

CONSULT YOUR SWEET'S! You'll find "everything electric" for machinery manufacturers in the General Electric section. 8579

BRASS AND BRONZE SCREWED FITTINGS

The dimensions in this new American Standard are for 125 lb threaded fittings of brass or bronze.

Contents:

Tables of center-to-end dimensions for straight fittings.
Dimensions of reducing fittings to be used when making patterns for specific fittings.
Recommendations for using pattern equipment for fittings.
Pressure-temperature ratings.
Recommendations for materials, marking, threading and tolerances.

B16.15—1947 **Price 65¢***

STEEL-SOCKET WELDING FITTINGS

This new American Standard establishes basic dimensions for fittings up to and including the 3" size on tees, 90-deg ells, 45-deg ells, crosses, couplings, and half couplings. It recommends that reducing sizes have the same center-to-bottom of socket dimension as the largest size of reducing fittings, and it presents the approved dimensions for socket wall thickness, depth of socket, bore of fitting, bore of socket, and concentricity of bores.

Recommendations are also given for materials, metal thickness, finish, tolerances, tests and marking.

B16.11—1946 **Price 60¢***

JUST PUBLISHED — A new edition of the American Standard on INVOLUTE SPLINES

Several years of continuous investigation and study of industrial requirements for improved spline elements have resulted in the development of an Involute Spline Standard which is broadly flexible in application and which includes shaft sizes ranging from the largest industrial drives to the finest splines used in aircraft and in precision instruments. The main features of this Revised Standard are:

Size ranges are not predicated on metric bearing bores in 5-mm steps
The range is covered from one/two (1/2) diametral pitch to 48/96 diametral pitch.
The number of spline keys are no longer restricted to 6-10-16-24 and 36.
Every number of spline keys from 6 to 50 may be used in any pitch.
There are 15 diametral pitches.
Three types of fits are provided—major diameter, side bearing, and minor diameter.
Pressure Angle is 30-degree for all splines.

A table of spline selections for anti-friction bearings is included.
Formulae for calculating pin measurements are given; also tables of pin sizes and measurement values for each pitch and number of teeth for both internal and external splines.
There are formulae for loads and shear stress applicable to all pitches and numbers of teeth.
Tolerances for external and internal splines.
Dimensions for involute spline hobs.
Tools for interna. teeth

B5.15—1946 **Price $1.00***

Professional Engineers . . .
How accurate is your information on COLLECTIVE BARGAINING?

To give professional engineering a background against which they may interpret and appraise current developments in the field of labor relations, the Engineers Joint Council and the National Society of Professional Engineers are now sponsoring the preparation of three manuals on the subject.

Part I dealing with The National Labor Relations Act and Professional Employees has just been published. It presents the essential features of The National Labor Relations Act, reviews professional societies activities with respect to collective bargaining for professional engineers, examines certain proposals to modify this Act, appraises the various courses of action which professional employees have taken under the Act, outlines the advantages and disadvantages of the various types of labor organizations which are open to professional employees, and discusses the conditions that must be met, steps that must be taken, and the responsibilities involved in establishing a labor organization for professional employees.

The Appendices include The National Labor Relations Act, organizations serving as collective bargain agencies for professional employees, and samples of forms pertaining to collective bargaining.

Price $1.00 net.

IN PREPARATION

Part II—Collective Bargaining, Mediation and Arbitration will deal with the purpose and content of collective bargaining, the process of negotiating and living under a contract, and the nature and place of mediation and arbitration, and the settlement of industrial disputes.

Part III will treat with the objectives, structure and tactics of labor organization. It will present a brief history of the American Labor Movement, examine the structure and functions of labor organizations, and portray union organizing tactics and strike strategy and tactics.

Why not make sure of receiving these Manuals as they come off the press, by ordering copies now?

** 20% Discount to A.S.M.E. Members*

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
Publication-Sales Dept. 29 West 39th St., New York 18, N. Y.

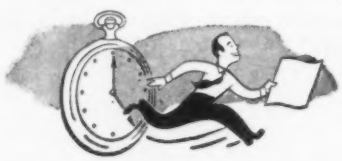
NEW! THE OZALID STREAMLINER

- Reproduces your engineering and architectural drawings in seconds—also your typed, printed, photographic material.
- Moderately priced . . . designed for the thousands of drafting rooms that want these 5 EXTRA VALUES in Printmaking at no extra cost—

1. EFFICIENCY! You always get positive (not negative) prints direct from your tracings . . . prints that are sharper, brighter, much easier for you to read, check, and make notations on.

You produce these without waste of material or waste of motion. Your tracings can be up to 42 inches wide, any length . . . and can be printed either on rolls of Ozalid sensitized paper or on cut sheets of matching size.

Your prints are always delivered dry, ready for immediate use . . . after just two simple operations—Exposure and Dry Development.



2. SPEED! ONLY 25 seconds to reproduce your standard-size tracings, specification and data sheets, etc.

3. ECONOMY! An 8½ x 11-inch reproduction costs you *one cent;* 11 x 17 inches, two cents . . . and so on. The Ozalid Streamliner soon pays for itself . . . in time, labor, and dollars saved.

With it, you can also effect amazing short cuts in design. For example—eliminate redrafting when changing obsolete drawings . . . combine the details of separate tracings on *one* print . . . re-

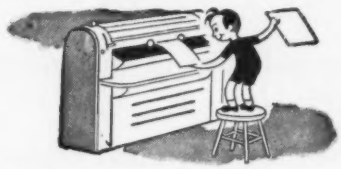
claim old or worn tracings . . . make transparent overlays in different colors.

4. VERSATILITY! You can reproduce the lines and images of any original in black, blue, red, sepia, or yellow . . . on paper, cloth, foil, film, or plastic.

Simply use the Ozalid sensitized material you think best for job at hand; e.g., use identifying colors for prints of separate departments or operations . . . DRYPHOTO to produce beautiful con-

tinuous-tone prints from film positives (which can be made from any negative) . . . OZAPLASTIC to produce oilproof, waterproof prints for shop or field use. *All* prints are made in same fast, economical manner.

5. SIMPLICITY! NOW—printmaking is an easy desk job, automatic in practically every detail.



Anyone can feed originals and sensitized material into the Ozalid Streamliner. Prints are delivered on top, stacked in order—within easy reach of the operator, who does not have to leave her chair.

You can install your Streamliner anywhere; it requires only 11 square feet of floor space.

Write today for free, illustrated booklet . . . showing all the ways you can use the new OZALID STREAMLINER . . . and containing actual reproductions — like those you can make.

DEPT. 233

Gentlemen:
Please send New Ozalid Streamliner booklet . . . containing reproductions of drawn, typed, printed, and photographic material. No obligation.

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OZALID

DIVISION OF
GENERAL ANILINE AND FILM CORPORATION
Johnson City, New York

Ozalid in Canada
Hughes Owens Co., Ltd., Montreal

HIGH I.Q. IN DESIGN
and Plant Operation

There is no phase of plant operation and production which does not involve the work of the mechanical engineer.

The design of the apparatus; the basic design of the plant in which it is used; its operation for profitable production: The creation, coordination and integration of ALL the mechanical factors are basically the work of mechanical engineers.

Responsibility of that magnitude calls for a high I.Q.

When the individual engineer has the advantage of wide experience his I.Q. enters the PLUS class. When the individual engineer adds to his own by drawing from the experience and skill of many other engineers, both the I.Q. and the PLUS go higher.

Keeping posted on what has already happened and has become current practice, is comparatively simple.

Keeping in constant touch with the more elusive factors which determine trends, and the practices of tomorrow, is not so simple.

But much of it is being done, thanks to the vision and organizing ability of eminent engineers. It is being done through the far-reaching co-operative activities of The American Society of Mechanical Engineers.

More than 23,000 engineers are now following basic developments and developments-in-the-making through the A.S.M.E. publication, MECHANICAL ENGINEERING.

These are men of responsibility and influence and purchasing power . . for all kinds of mechanical apparatus, as well as for parts and materials that go into the apparatus.

A high I.Q. in industrial advertising will go higher by taking advantage of the high I.Q. and purchasing power that can be reached through MECHANICAL ENGINEERING.

PERMANENT MAGNETS MAY DO IT BETTER

Here Permanent Magnets are Designed

···FOR RESULTS!

The Indiana Steel Products Company offers you the advantages of the largest facilities in the world for the manufacture of permanent magnets and complete permanent magnet sub-assemblies.

Results that pay off in performance are the results you get in permanent magnets made by *The Indiana Steel Products Company.* Here permanent magnets are functionally designed and manufactured to meet exacting specifications for *more efficient and economical* performance of the device or instrument they serve.

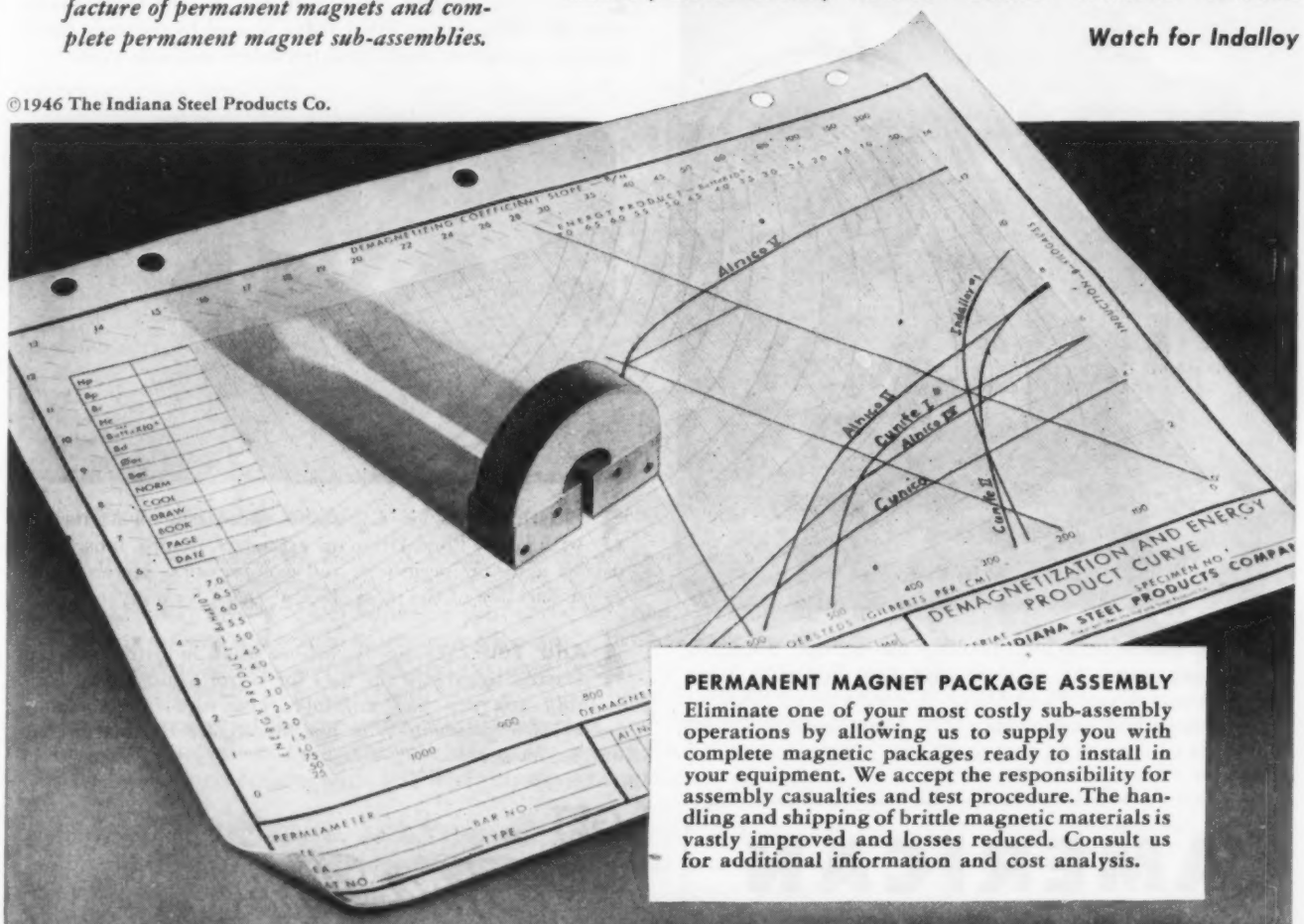
This Is No Secret Formula...

The chart shows the typical demagnetization and energy product curves on which our engineers base their calculations. It shows the characteristics of various kinds of permanent magnet materials which can be expected in our production, and from which the optimum designs can be determined. Such fundamental information permits us to engineer the inside of your magnet so that each one will give you a maximum result.

ALNICO (Cast and Sintered) • CUNICO • CUNIFE • VECTOLITE • SILMANAL

Watch for Indalloy

©1946 The Indiana Steel Products Co.



PERMANENT MAGNET PACKAGE ASSEMBLY

Eliminate one of your most costly sub-assembly operations by allowing us to supply you with complete magnetic packages ready to install in your equipment. We accept the responsibility for assembly casualties and test procedure. The handling and shipping of brittle magnetic materials is vastly improved and losses reduced. Consult us for additional information and cost analysis.

THE INDIANA STEEL PRODUCTS COMPANY

PRODUCERS OF "PACKAGED ENERGY"

6 NORTH MICHIGAN AVENUE • CHICAGO 2, ILL.

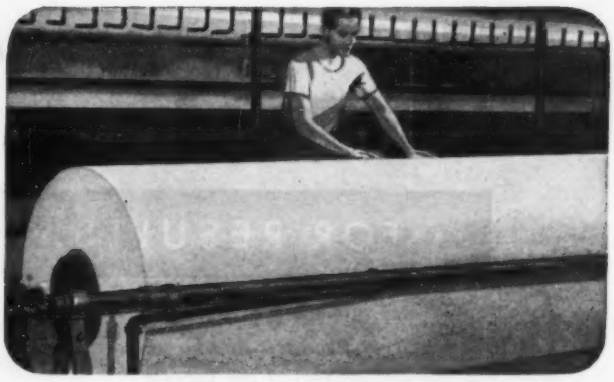
ISP

SPECIALISTS IN PERMANENT MAGNETS SINCE 1910

PLANTS { VALPARAISO, INDIANA / STAMFORD, CONN.

Watch industry Fluid-Drive* ahead!

1 Cable Manufacturing. Looking for savings? Standard, constant speed AC motors gain new flexibility when equipped with Gýrol Fluid Drive. A vortex of oil takes up the load smoothly—pulls evenly from dead stop to full speed —protects equipment against overloads.



2 Paper. Gýrol Fluid Drive has helped paper manufacturers to simplify equipment and to cut maintenance costs. In this industry Fluid Drive is used to transmit power to slitters, coaters, draft fans, rewinders and conveyors.

3 Plastics. You get adjustable speed control at its best with Gýrol Fluid Drive on extruders, pumps, fans, rotary driers, agitators, crushers and compressors. Here's faster, easier selection of the most efficient speed for a given process.

4 And You? We firmly believe that industry has only started to explore the uses for Gýrol Fluid Drive. *Quite possibly you can find profitable new uses in your plant, processes or product.* Why not investigate the matter with our engineers?

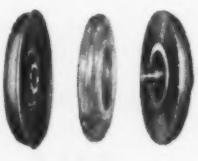
AMERICAN BLOWER

DETROIT 32, MICHIGAN

In Canada: CANADIAN SIROCCO CO., LTD., Windsor, Ont.

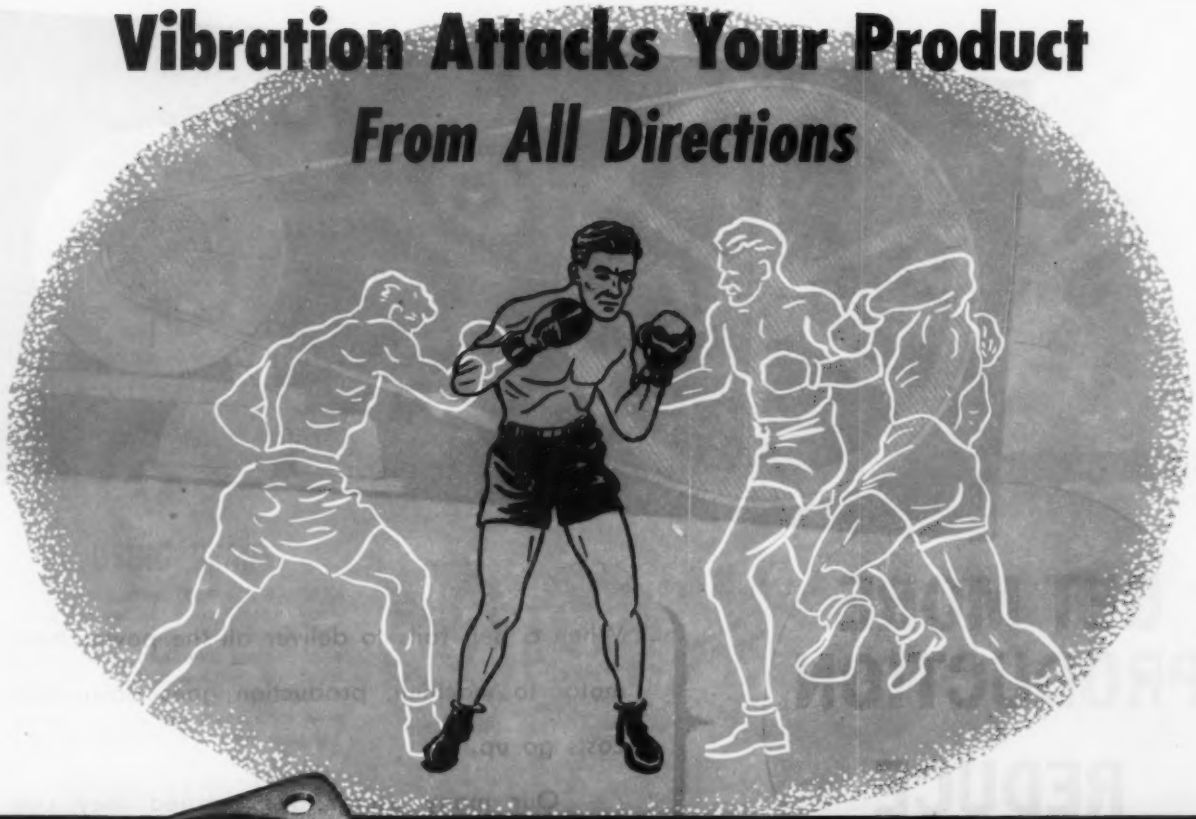
Division of American Radiator & Standard Sanitary corporation

GET GÝROL *Fluid Drive*



* **Gýrol Fluid Drive** *is a fluid power transmission pioneered and developed for American industry by American Blower. It is used wherever smooth transmission of power or adjustable speed control is desired. Looking beyond the long list of applications already developed, we will gladly work with you to find new ways to "Fluid-Drive Ahead!"*

Vibration Attacks Your Product From All Directions



Isolate It Completely with NEW LORD MULTIPLANE MOUNTINGS

a new standard of product performance . . .

Vibration now can be isolated from your product, through a greater range of frequencies *regardless of the direction of disturbing forces* . . . with new MULTIPLANE MOUNTINGS pioneered by Lord. Here, then, is a brand new standard of vibration control . . . and a brand new opportunity to boost performance standards and product sales.

Lord MULTIPLANE MOUNTINGS not only provide all-directional freedom—universal softness in all planes—but are simple, compact, one-piece mountings that give your design engineer the plus advantages of complete protection with less weight, easy installation, at very reasonable cost.

Like all Lord Products, MULTIPLANE MOUNTINGS feature the same *permanently-bonded-rubber-in-shear* principle that has made Lord first in the field of Vibration Control and Bonded Rubber Products. Put this specialized experience, backed by Lord research and engineering, to work on your problems. We'll be only too glad to serve you.

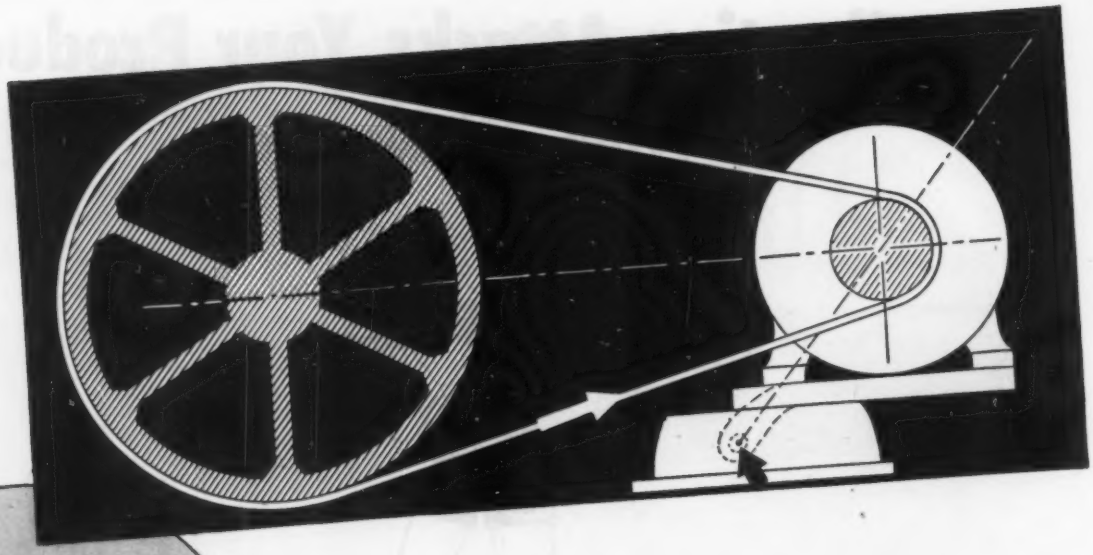
For more information write for Bulletin 106

LORD MANUFACTURING COMPANY ERIE, PA.

FIELD OFFICES { New York, N.Y. Providence, R. I. Washington, D. C. Detroit, Mich. Chicago, Ill. Burbank, Cal.
Canadian Representative: Railway & Power Engineering Corp., Ltd., Toronto, Canada.

Lord MULTIPLANE MOUNTINGS are ideal for instruments, electronic equipment, and other devices of high sensitivity, not to mention other applications including engine-generator sets, air-conditioning units, pumps, blowers, etc. Features like these insure vastly improved performance:

- Simple, low-weight, one-piece construction.
- Easy, convenient, low-cost installation.
- Long life thru large bonding area—low bond stress.
- All-directional softness from multiple shear areas.
- Progressive cushioning of shockloads by snubbing shoulder.



GET MORE PRODUCTION • REDUCE COSTS

- Tannate retains its high efficiency throughout its long service life.
- Resists heat, oil, moisture and many weak chemicals.
- Exceptional pulley grip, strength, and resistance to stretch and slippage.
- Higher quality of output through steady flow of power under varying conditions of load.
- More production with less maintenance.

When a belt fails to deliver all the power from motor to machine, production goes down and costs go up.

Our many users have learned they can depend on Tannate to keep machines at constant high speeds with fewer letdowns for maintenance. When the load varies, the weight of the motor on the pivoted Rockwood base automatically adjusts the belt tension . . . so that at no time is the high transmission efficiency of the Tannate belt impaired. The combined facilities for research and engineering behind Tannate-Rockwood short center drives are unequalled. A consultation with one of our engineers can point real savings to you.

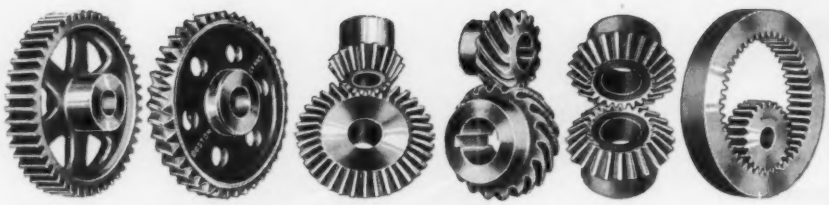
J. E. RHOADS & SONS 35 N. SIXTH ST., PHILA. 6, PA.
Established 1702 NEW YORK • CHICAGO • ATLANTA

RHOADS *Tannate* WATERSHED LEATHER BELTING *Tannate-Rockwood* SHORT CENTER DRIVE

How shall I rig up that drive?

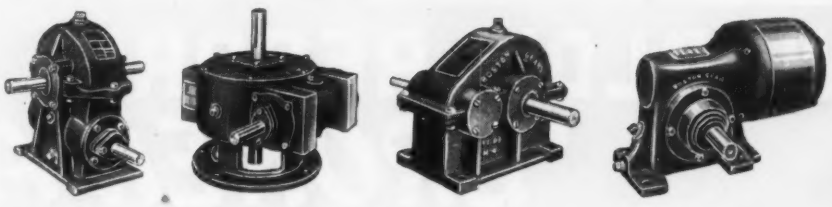
USING GEARS

Your drive may require any one of these types of gears — spur gears, worms and worm gears, bevels, helicals, miters, internal gears — or a combination of these types. For easier selection of your requirements the Boston Catalog lists many stock sizes from ¼" diameter up to 40" diameter.



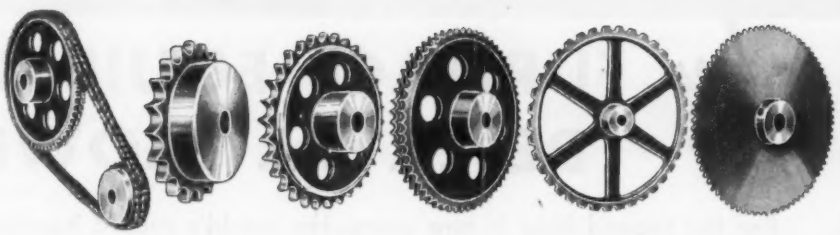
SPEED REDUCERS

Made-to-order gear housings and lubricating problems are eliminated when you select a modern speed reducer — a completely engineered and inclosed gear box ready for installation. The Boston Catalog lists 20 different speed reducer types and also gives you valuable data to use in the selection of the right unit for your drive.



SPROCKETS & CHAIN

For more flexibility in a positive drive, sprockets and chain may be your answer. Long center distances are a primary feature. Stock sprockets are listed in the Boston Catalog if your drive is from "flea" power up to 40 horsepower. For your information complete specifications and selection data are given in the Boston Catalog.



Where and how do I buy these products?

SIMPLY ORDER BY CATALOG NUMBER FROM YOUR NEAREST DISTRIBUTOR. SEND FOR CATALOG 54 AND COMPLETE LIST OF 65 STOCKING DISTRIBUTORS. BOSTON GEAR WORKS, INC., NORTH QUINCY 71, MASS.

BOSTON GEAR WORKS, INC., NORTH QUINCY 71, MASS.

Please send me ..... copies of your General Catalog 54 and complete list of stocking distributors.

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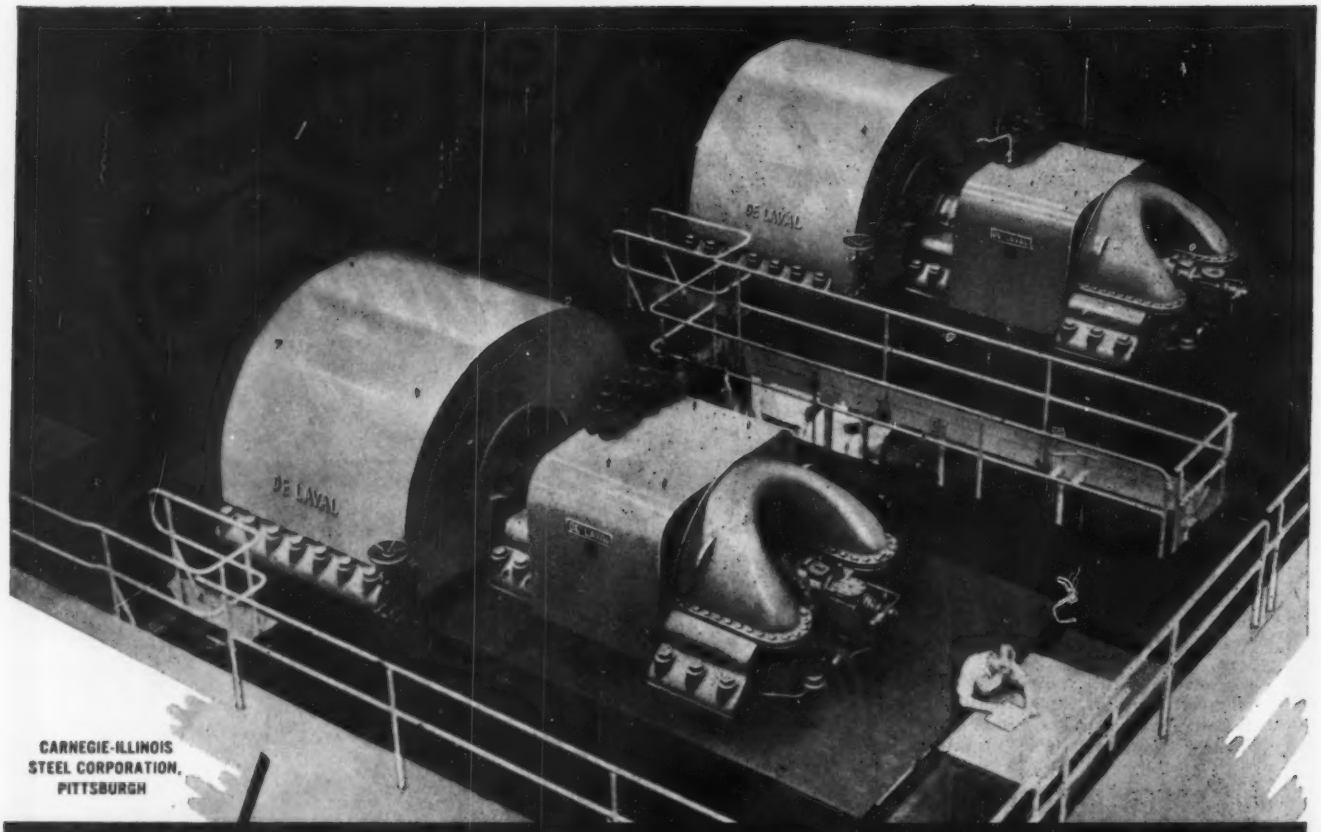
COMPANY_____

STREET_____

CITY_____ ZONE_____ STATE_____



CARNEGIE-ILLINOIS STEEL CORPORATION, PITTSBURGH

WORLD'S RECORD BROKEN AGAIN!

by FURNACE EQUIPPED WITH DE LAVAL BLOWERS

For the second time in two years, the world's record has been broken for pig iron production from a single furnace served with De Laval turbine-driven blast furnace blowers.

During the month of July, 1945 the No. 2 Furnace of the Edgar Thompson Works of the Carnegie-Illinois Steel Corp. produced a record-breaking 50,590 tons.

The De Laval blowers at the Edgar Thompson Works, with a capacity of 97,800 c.f.m. against 30 p.s.i., were designed for the highest maximum steam pressure (700 p.s.i) and temperature (825 F.) ever used for this service.

CONSULT THE DE LAVAL STEAM TURBINE CO. FOR CENTRIFUGAL BLOWERS AND COMPRESSORS OF ADVANCED DESIGN.

3833

TURBINES · HELICAL GEARS
WORM GEAR SPEED REDUCERS
CENTRIFUGAL PUMPS · CENTRIFUGAL BLOWERS and COMPRESSORS · IMO OIL PUMPS

DE LAVAL

STEAM TURBINE COMPANY · TRENTON 2, NEW JERSEY

SALES OFFICES ATLANTA · BOSTON · CHARLOTTE · CHICAGO · CLEVELAND · DENVER · DETROIT · HELENA · HONOLULU · HOUSTON · KANSAS CITY · LOS ANGELES · MANILA · MONTREAL · NEW HAVEN · NEW ORLEANS · NEW YORK · PHILADELPHIA · PITTSBURGH · ROCHESTER · ST. PAUL · SALT LAKE CITY · SAN FRANCISCO · SEATTLE · TORONTO · TULSA · VANCOUVER · WASHINGTON, D.C. · WINNIPEG
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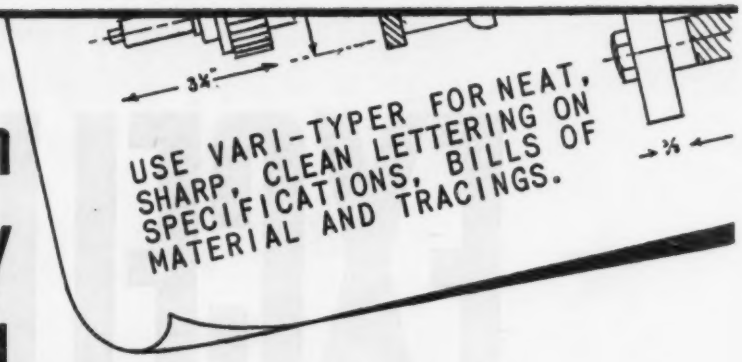
Relieves Draftsmen of Slow, Costly Lettering



. . . at G.E., G.M., A.T.&T. and many smaller concerns

Draftsmen are freed of tedious hand lettering . . . given an opportunity to do creative engineering work . . . with the new streamlined Vari-Typer* Lettering Machine.

A typist operates Vari-Typer. *In one day* she can Vari-Type drawings, tracings, bills of material, and specifications it would take a skilled draftsman *four days* to hand letter -- four dull, unproductive days. A circuit breaker manufacturer reports that Vari-Typer " saved our draftsmen 2,000 hours of hand lettering on one set of plans."

The high quality, legibility, sharpness and clarity of engineering work done with Vari-Typer is demonstrated by its large-scale use in the exacting drafting rooms of General Electric, Chrysler, General Motors, American Telephone and Telegraph, and innumerable smaller concerns. Vari-Typed lettering is uniform and clear . . . it reproduces perfectly in blueprints and all other kinds of prints . . . it prevents errors caused by any imperfect hand lettering . . . it means fewer drawings rejected or done over.

There's no limit to the width of a tracing easily handled on Vari-Typer . . . and it's just as useful on small drawings. Vari-Typer has instantly-changeable type available in many sizes and styles for every language . . . with almost every known mathematical and other technical symbol.

If you or your staff have never seen a Vari-Typer Lettering Machine in operation, we'll be glad to demonstrate without obligation . . . or send samples of engineering work done on Vari-Typer. Write today to Dept. ME-5, Ralph C. Coxhead Corp., 333 Avenue of the Americas, New York 14, N.Y.

*Reg. U. S. Pat. Off. & foreign countries
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LETTERING MACHINE

RALPH C. COXHEAD CORPORATION

DEPT. ME-5, 333 AVENUE OF THE AMERICAS, NEW YORK 14, N.Y.

★ EXCELLENT ★

AGE RESISTANCE

RESILIENT parts made from HYCAR American rubber resist the aging effects of air, sunlight, ozone, heat, cold, and all other types of oxidation. That's why they *stay* resilient—and stay on the job for a long, long time.

Other important properties of HYCAR American rubber are shown in the box at the right. And it's important to know that these properties may be had in an almost limitless number of combinations—each compounded to meet a given set of service conditions.

We make no finished products of HYCAR. But we urge you to ask your supplier for parts made from this versatile material. You'll learn for yourself that it's wise to use HYCAR—in difficult or routine applications—for long-time, dependable performance. For more information, please write Dept. HF-5, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio.

CHECK THESE SUPERIOR FEATURES OF HYCAR

1. *EXTREME OIL RESISTANCE — insuring dimensional stability of parts.*
2. *HIGH TEMPERATURE RESISTANCE—up to 250° F. dry heat; up to 300° F. hot oil.*
3. *ABRASION RESISTANCE—50% greater than natural rubber.*
4. *MINIMUM COLD FLOW—even at elevated temperatures.*
5. *LOW TEMPERATURE FLEXIBILITY — down to —65° F.*
6. *LIGHT WEIGHT—15% to 25% lighter than many other synthetic rubbers.*
7. *AGE RESISTANCE—exceptionally resistant to checking or cracking from oxidation.*
8. *HARDNESS RANGE—compounds can be varied from extremely soft to bone hard.*
9. *NON-ADHERENT TO METAL—compounds will not adhere to metals even after prolonged contact under pressure. (Metal adhesions can be readily obtained when desired.)*

Hycar

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American Rubber

B. F. Goodrich Chemical Company

A DIVISION OF THE B. F. GOODRICH COMPANY

GEON polyvinyl materials • HYCAR American rubber • KRISTON thermosetting resins • GOOD-RITE chemicals

INSIDE STORY...

with a promise for you

This standard muffler practically fell apart—the outer shell has been cut away to show the disintegrated interior.

But now that the problem has been solved by making a durable muffler interior of Inconel, there is every reason to expect that this new muffler interior will last as long as the truck itself.

Even in grueling cross-country service trucks can go half a million miles nowadays.

But the mufflers can't.

They burn out, corrode away and shake themselves to pieces so fast that truck owners have to lay up a truck ten times or more during its life to put in another new muffler.

But a well-known manufacturer of trucks and buses got an idea. He realized that airplane exhaust stacks have to stand up under conditions far worse than any truck muffler ever meets: Yellow-white heat. Corrosive attack by flaming exhaust gases. Incessant vibration.

Those airplane stacks are made of Inconel*, an INCO Nickel Alloy especially suited for high temperature service. And it's nothing unusual for them to last a million flying miles.

Why not try Inconel for truck mufflers?

That's exactly what the manufacturer did. After exhaustive tests on fifteen other alloys in comparison with Inconel he reports—

"According to our tests, we believe Inconel to be good for the life of the vehicle."

If *you* are looking for an answer to a high temperature problem, write for a copy of "Engineering Properties of Inconel." If your problem is different, one of the other strong, hard, corrosion-resisting INCO Nickel Alloys may be exactly what you want. Our technical assistance is yours whenever you ask for it.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 WALL STREET **NEW YORK 5, N. Y.**

*Reg. U. S. Pat. Off.

NICKEL (INCO TRADE MARK) ALLOYS

MONEL* • "K"* MONEL • "R"* MONEL • "KR"* MONEL • "S"* MONEL • INCONEL* • NICKEL • "L"* NICKEL • "Z"* NICKEL

TREATING LAKE ERIE WATER FOR BOILER FEED

COCHRANE

HOT PROCESS SOFTENER

AT the Perry Plant of the INTERLAKE IRON CORPORATION at Erie, Pa., a Cochrane Hot Process Softener is used to treat Erie City water (Lake Erie water, already partly treated) for feed water, supplying two 50,000 lb/hr and one 75,000 lb/hr boilers. In the photograph above is shown the sedimentation tank of the 14,000/gph Cochrane Softener, mounted outside the building on steel and concrete supports. Lime and soda ash to the sedimentation tank are supplemented by phosphate fed directly to the boilers. The lower photo shows the two Cochrane 8'6" vertical pressure filters. Other Cochrane products installed at this plant are a Continuous Blowoff System and a 10" Multiport Back Pressure Relief Valve.

COCHRANE CORPORATION ° ° ° °
3142 N. 17th Street, PHILADELPHIA 32, PA.

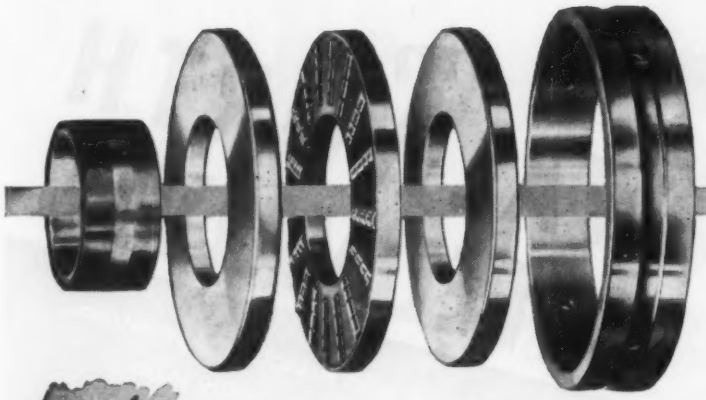
SPLIT YOUR LOAD IN TWO !

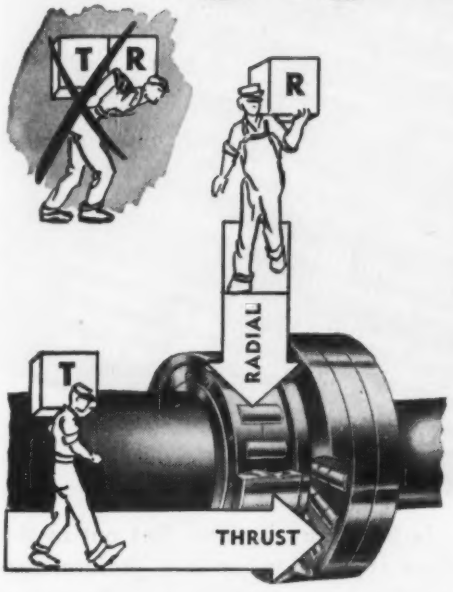
with

ROLLWAY

RIGHT-ANGLE-LOADED

BEARINGS

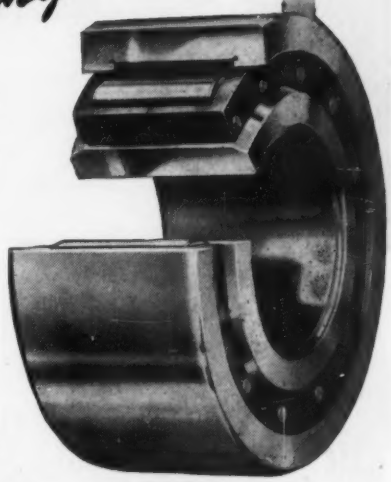




***Right-Angle Loading splits compound loads into the two component parts of pure radial and pure thrust... and carries each of these components on separate bearing assemblies.* Simple but scientifically sound.**

1. **Keeps bearings free of complicated stresses**
2. **Gives longer bearing life with higher capacity**
3. **Cuts maintenance cost and lay-up time**

What Right-Angle-Loading Does!



1. Prevents wedging of rollers and pinch-out. Reduces roller end-rub, with its wearing friction. Holds starting and operating torque at a minimum.
2. Since only pure radial or pure thrust loads can be imposed upon any single bearing assembly, unit pressures are reduced substantially.
3. Since all loads are carried at right-angles to the roller surface, compound or oblique loads are avoided and so are the resultants of the oblique loads.
4. Right-angle loading permits greater radial or thrust load-carrying capacity in any given dimension.
5. Right-angle loading assures solid cylindrical rollers of greater roller mass and uniform roller cross-section . . . greater resistance to shock loads and vibration . . . longer life expectancy under continuous heavy-duty service.

Free Service! ***Select the RIGHT bearings for YOUR particular needs . . .***

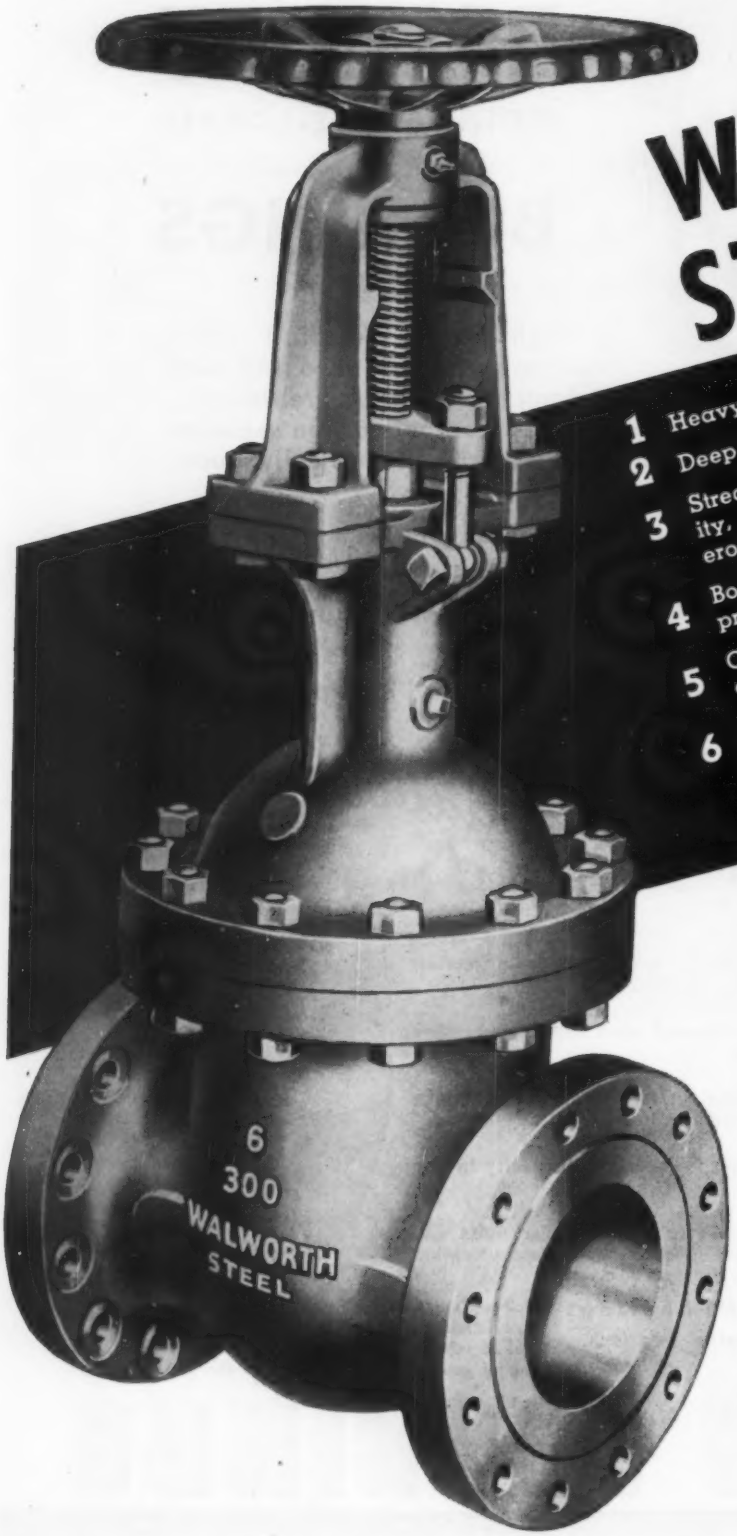
Rollway engineers will gladly make necessary calculations, drawings and supply other required information for a complete understanding of your bearing problem. *No charge.*

ROLLWAY BEARINGS

ROLLWAY BEARING COMPANY, INC., SYRACUSE, N. Y.

SALES OFFICES: Philadelphia • Boston • Pittsburgh • Cleveland • Detroit • Chicago • Minneapolis • Houston • Los Angeles

You get all these BIG features in WALWORTH STEEL VALVES



1. Heavy steel walls for extra strength and protection.
2. Deep stuffing boxes to eliminate costly leaks.
3. Streamlined ports to make possible a high velocity, non-turbulent flow, and reduces possible erosion.
4. Bodies and bonnets engineered to withstand pressure and minimize distortion.
5. Cast body guide rib faces, machined to insure accurate disc centering.
6. Exact design, metallurgy and construction of yoke nuts, bonnet bushings, gland followers, handwheels and other vital parts to assure better service for a longer period of time.

Is there any wonder that out in the field, where approval is based on performance under actual operating conditions, industry has put its O.K. on Walworth Steel Valves?

Tough . . . wear resistant . . . dependable, these valves are produced in gate and globe types, in sizes to cover practically every service requirement. They are excellent examples of Walworth leadership . . . leadership that has made the Walworth valves famous throughout the world.

Walworth Catalog 42 gives complete information regarding Steel Valves as well as the full line of Walworth valves and fittings in bronze and iron. Your copy may be obtained upon request. Whenever you need valves — whether steel, bronze or iron — remember Walworth for dependability, economy, and long service life.

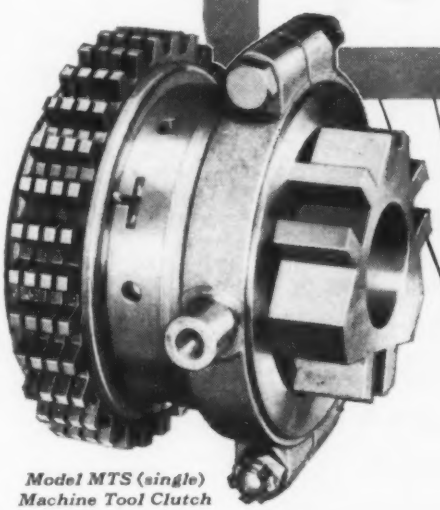
WALWORTH
valves and fittings
60 EAST 42nd ST., NEW YORK 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

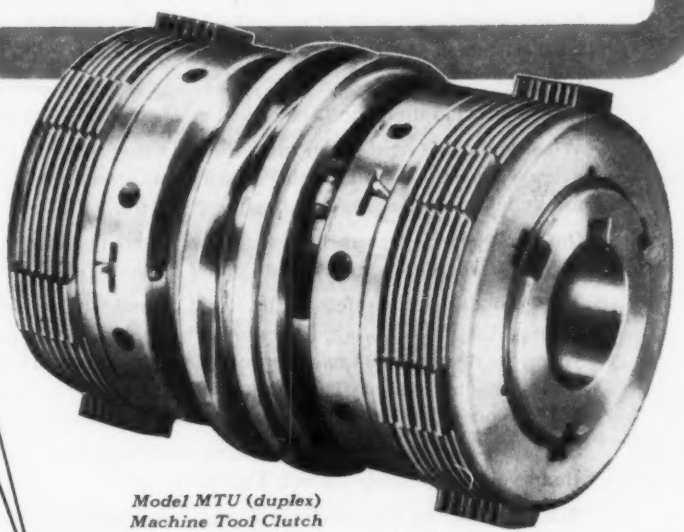
Smooth speed... easy accuracy

Smooth, easy engagement and quick positive release of your machine tool clutches are prime essentials if your precision work is to be accomplished with sufficient speed and accuracy to return a profit. Twin Disc Machine Tool Clutches are designed, built and applied to assure these necessary factors.

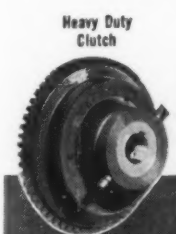
Write the Twin Disc Clutch Company, Racine, Wisconsin, for Bulletin No. 134A, which gives complete data on the Twin Disc Model MTS (single) and Model MTU (duplex) Machine Tool Clutches, both oil and dry types. TWIN DISC CLUTCH COMPANY, Racine, Wisconsin (Hydraulic Division, Rockford, Illinois).



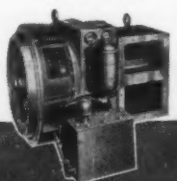
Model MTS (single) Machine Tool Clutch



Model MTU (duplex) Machine Tool Clutch

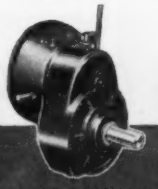


Heavy Duty Clutch



Hydraulic Torque Converter

Hydraulic Coupling

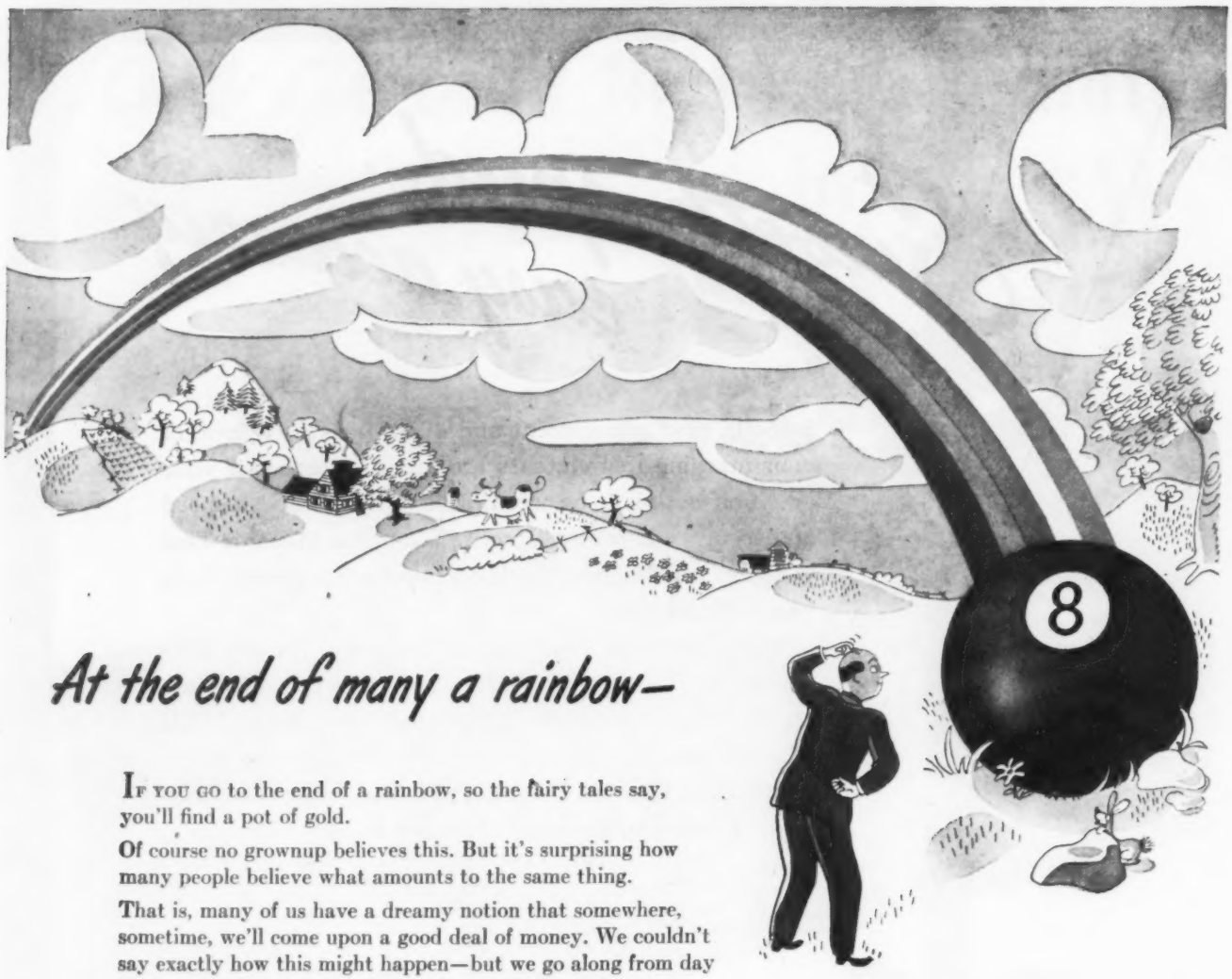


Reduction Gear

Marine Gear

TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES
REG. U. S. PAT. OFF.

SPECIALISTS IN INDUSTRIAL CLUTCHES SINCE 1918



At the end of many a rainbow—

If you go to the end of a rainbow, so the fairy tales say, you'll find a pot of gold.

Of course no grownup believes this. But it's surprising how many people believe what amounts to the same thing.

That is, many of us have a dreamy notion that somewhere, sometime, we'll come upon a good deal of money. We couldn't say exactly how this might happen—but we go along from day to day, spending nearly all we make, and believing that *somehow* our financial future will take care of itself.

Unfortunately, this sort of rainbow-chasing is much more apt to make you wind up behind the eight ball than with a pot of gold.

When you come right down to it, the only sure-fire way the average man can plan financial security for himself and his family is through saving—*and saving regularly.*

One of the soundest, most convenient ways to save is by buying U. S. Savings Bonds through the Payroll Plan.

These bonds are the safest in the world. When you buy 'em through the Payroll Plan, they mount up fast. And in just 10 years, they pay you $4 back for every $3 you put in. They'll come in mighty, mighty handy when the time comes to send your kids to college, to buy a house, or to weather a rainy day.

So isn't it just plain common sense to buy every U. S. Savings Bond you can possibly afford? You bet it is!

P. S. You can buy U. S. Savings Bonds at any bank or post office, as well as at your place of business.

SAVE THE EASY WAY... BUY YOUR BONDS THROUGH PAYROLL SAVINGS

Contributed by this magazine in co-operation with the Magazine Publishers of America as a public service.

The TERRY TURBINE

225 TERRY TURBINES
SERVE THE CITIES SERVICE REFINING CORP. AT LAKE CHARLES, LA.

These 225 Specially Designed Terry Turbines are used to drive pumps and compressors at the Cities Service Tutwiler Refinery.

Typical Units are shown above. At the left is an 1800 H. P. condensing multi-staged Turbine direct connected to a blower. At the right are two 175 H. P. Terry solid wheel turbines driving pumps.

The same engineering talent and manufacturing facilities that produced these turbines are available to assist you in obtaining efficient power generation.

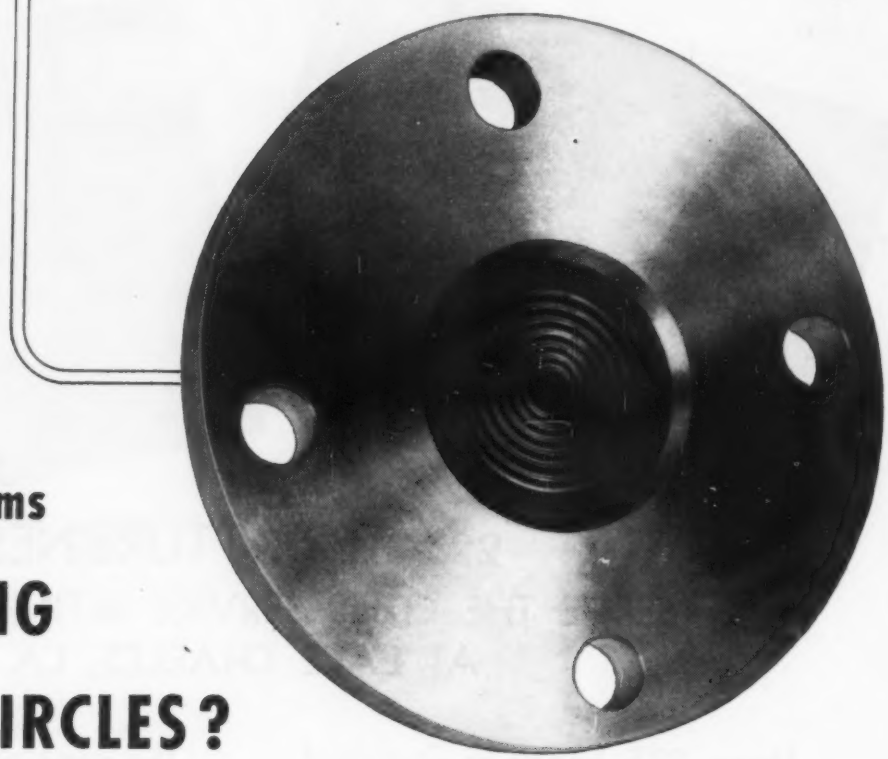
Any of our District Representatives will be pleased to give you full information on a turbine drive to meet your requirements. No obligation. May we send you descriptive bulletins?

T-1166

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

This Taylor Liquid Level Transmitter consists of:

1. *3-inch ASA 150 psi Type 304 stainless steel flange.*
2. *3-inch corrugated Type 304 stainless steel diaphragm.*
3. *A sensing unit.*



Liquid level problems got you RUNNING AROUND IN CIRCLES?

HERE'S a liquid level transmitter that will save you grief—because it can't clog up! The new Taylor 229R accurately measures the liquid level of slurries, soap, paper pulp, or any other viscous or corrosive liquids containing solids. It's a simple, highly responsive instrument built on the force-balance principle. Usable for liquid level ranges within the limits of 12 inches and 450 inches of water.

Here's how it works. The pressure of the head of liquid is exerted against the diaphragm attached to the flange and is balanced by an equivalent air pressure in back of the diaphragm. This back pressure is transmitted to a Taylor indicating, recording or controlling receiver which can be located anywhere you want it for a steadily dependable indication, record or control of liquid level.

For full details write for Bulletin 98069 or ask your Taylor Field Engineer. Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada. *Instruments for indicating, recording or controlling temperature, pressure, humidity, flow and liquid level.*

Taylor Instruments

MEAN

ACCURACY FIRST

IN HOME AND INDUSTRY

PLANNED POWER TRANSMISSION . . .
THE Wood's WAY OF CONTROLLING YOUR APPLIED HORSEPOWER . . .

to increase your production while reducing your maintenance, replacement and repair costs.

Wood's Long-Life Line Products are carefully designed and precision-made. Every product has inherent quality built in it. Each of them is the result of sound engineering, the best of materials and the time-proven manufacturing methods of more than 88 years' experience in the production of Quality Power Transmission Equipment.

To insure smooth, trouble-free operation . . . include Wood's Products in your designs of new and reconditioned machines and layouts.

WOOD'S PRODUCTS
FOR POWER TRANSMISSION

Pulleys • Clutches • Hangers
Pillow Blocks • Couplings
Bearings • Collars • V-Belt
Sheaves and Complete Drives

the LONG LIFE LINE

T. B. Wood's SONS COMPANY
CHAMBERSBURG, PA.

BRANCHES: BOSTON, MASS. NEWARK, N. J. PITTSBURGH, PA. CLEVELAND, OHIO DETROIT, MICH.

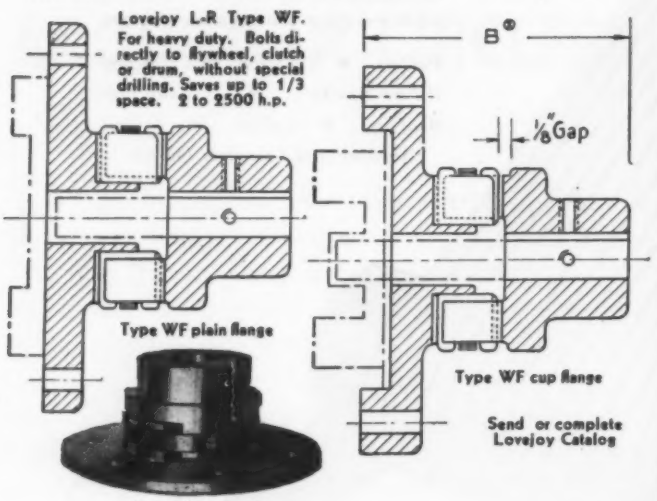
What are Plant Engineers Talking About NOW...?
...INCREASED LOADS

Demands on power—how to provide adequate means for *today's* requirements.

Here's One Way: Insure *full*, truer, smoother power flow from either present or new equipment with

LOVEJOY L-R Flexible Couplings

Correct for misalignment, oscillation, backlash, chatter. Take up shock and vibration. Lovejoy couplings *require no lubrication.* (That's *another* subject that has come to the fore.) Cushions always in sight. NO TEAR-DOWNS FOR CHANGING.


Lovejoy L-R Type WF. For heavy duty. Bolts directly to flywheel, clutch or drum, without special drilling. Saves up to 1/3 space. 2 to 2500 h.p.
B
1/8" Gap
Type WF plain flange
Type WF cup flange
Send or complete Lovejoy Catalog

Pat. & Pats. Pend.

Shows couplings *for every kind of duty,* 1/6 to 2500 h.p. Also brings you Lovejoy's BIG HELP, Quick-Finding Selector Charts that lead you right to the couplings you need, with complete engineering data and prices right at hand. Should be in every plant engineer's file. Wire or write

Mfd. by

LOVEJOY Flexible Coupling Co.

5032 W. Lake St., Chicago 44, Ill.

Also mfrs. of Lovejoy-IDEAL Variable Speed Controls

Ledeen

HEAVY DUTY CYLINDERS

Wherever you have to tilt or turn, push or pull, open or close, lift or lower, press or squeeze.

•

ENGINEERING PRODUCTS CO.

LEDEEN MFG. DIVISION
1600 S. San Pedro St.
Los Angeles 15, Calif.

SEND FOR BULLETIN 453

MECHANICAL ENGINEERING

•

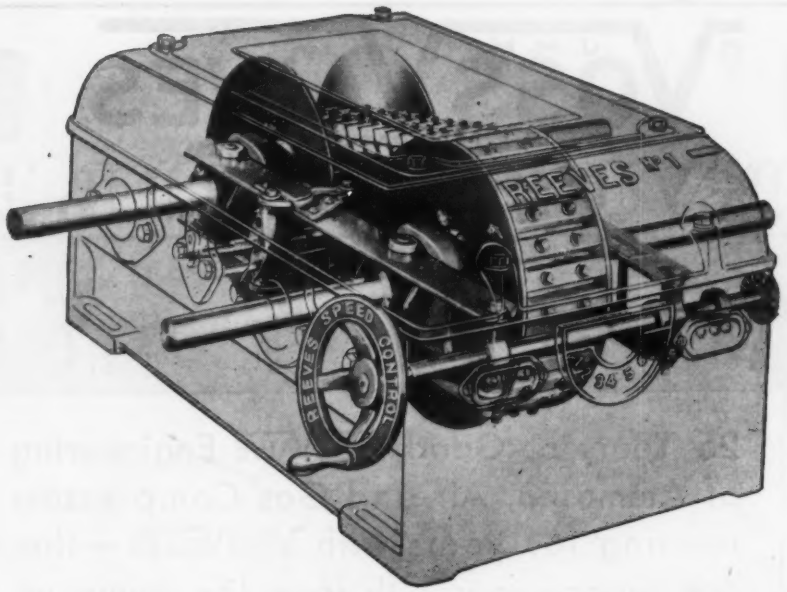
Monthly average circulation for six months ended December 31, 1946 as reported to the Audit Bureau of Circulations

22,556

•

A Gain of 2,051

OVER PREVIOUS SIX MONTHS



Industry's Approved Method of Accurate, Variable Speed Control

The "missionary" work for variable speed control has been done. On every hand, in every industry where operating conditions are subject to change, there is abundant evidence to support its claims for increased output, improved, uniform quality and reduced cost.

Your problem, then, is one of selection . . . of determining which type and make of variable speed drive is best for your particular need. In making that choice, consider these facts about infinite, stepless REEVES Speed Control:

Manufactured by a company with more than fifty years' specialized experience in this specialized field. Design based on a proved operating principle. Ruggedly constructed for trouble-free operation and easy maintenance without special training or tools.

Offered in a complete range of sizes, capacities and speed ratios, and furnished with any type of control . . . easily incorporated in new machine designs or applied to existing machines. Performance-proved in 260,000 installations and provided as standard equipment in 2,100 different makes of machines. Backed by a nation-wide engineering and service organization.

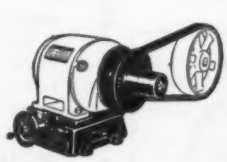
Think it over . . . this broad background of experience, this documented evidence of efficiency on any and all jobs . . . and we believe you will understand why REEVES is Industry's approved—*and proved*—method of variable speed control.

REEVES PULLEY COMPANY • COLUMBUS, INDIANA

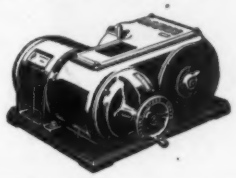
Recognized Leader in the Specialized Field of Speed Control Engineering

THE THREE BASIC REEVES SPEED CONTROL UNITS

VARIABLE SPEED TRANSMISSION for providing infinite, accurate speed flexibility over a wide range—2:1 to 16:1. Sizes—fractional to 87 hp.



VARI-SPEED MOTOR PULLEY converts any standard constant speed motor to a variable speed drive within 4:1 ratio. Sizes to 15 hp.



MOTODRIVE combines motor, speed varying mechanism and reduction gears in single compact unit. Speed variations 2:1 to 6:1 inclusive. Sizes to 15 hp.

Accurate Variable

REEVES Speed Control

Gives the Right Speed for Every Job!

1921 J. H. H. VOSS VALVES 1946
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SILVER JUBILEE

· EFFICIENCY · DURABILITY · ECONOMY · SAFETY ·

DESIGNED BY ENGINEERS

MADE BY CRAFTSMEN

25 Years of Good VOSS VALVE Engineering. Thousands of Ammonia, Air and Gas Compressors have been running for years with VOSS VALVES — the valves that are synonymous with long life, minimum repairs and uninterrupted service — that means increased production and economy of operation.

Endorsed By Thousands of Satisfied Users!

J. H. H. VOSS CO. 785 East 144th Street NEW YORK 54, N. Y.

for Free Movement and Unrestricted Flow— FLEXO JOINTS

The arrows point to connections made up of Flexo Joints and standard pipe. These connections keep the steam platens on these massive presses functioning safely and dependably—with minimum maintenance. Flexo Joints are sturdy, simple and accurate in their construction—give full 360° range of movement with completely unrestricted flow in all positions.

ONLY 4 SIMPLE PARTS...

No small parts, no springs, no ground surfaces to wear. Fully enclosed from grit and dirt. In four styles—standard pipe sizes from ¼" to 3".

STYLE "B"

Write for details and specifications.

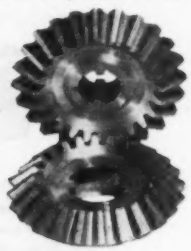
FLEXO SUPPLY COMPANY, Inc.
4652 Page Blvd. St. Louis 13, Mo.

In Canada: S. A. Armstrong, Ltd., 115 Dupont St., Toronto, Ont.

GEARS For INDUSTRY

Since 1888 . . .

We have been making many types and sizes of gears for industry. Vast plant facilities of the most modern gear cutting equipment assure capable handling of your *production* or *special* gear requirements.



HELICAL GEARS — Made from 1" to 60" in diameter and from 24 DP to 1½ DP.
BEVEL GEARS — Size range from 1" to 60" in diameter and from 24 DP to 1½ DP.
SPUR GEARS — Size range from ¾" to 150" in diameter. 32 DP to ¾ DP.
WORM GEARS — Made from 1" to 100" in diameter and from 24 DP to 1 DP.
MACHINE CUT RACKS — Cut in any length with teeth of 24 DP to 1 DP.

Your gear inquiries will receive immediate attention.

D. O. JAMES MANUFACTURING COMPANY
1140 W. MONROE STREET · CHICAGO, ILL.

"Half-inch or Thirty!"

You don't do much shopping around for the fittings you need when you deal with the Tube Turns distributor. He's got 'em or can get 'em for you, fast—welding elbows ranging in diameter from tiny half-inch to a mighty thirty inches, welding fittings of all types and thicknesses in a wide range of prices.

Tube Turns' complete line of TUBE-TURN welding fittings and flanges in grade A and grade B carbon steels contains more regularly manufactured items than any other line—more than 4,000! And this is supplemented by an extensive selection of items in a wide range of special metals and alloys —stainless steels, carbon moly steels, chrome moly steels, copper, aluminum, brass, monel metal, inconel, nickel, wrought iron.

Write for the name of your nearest Tube Turns distributor, and for facts about how the fittings that become part of the pipe serve others in your industry.

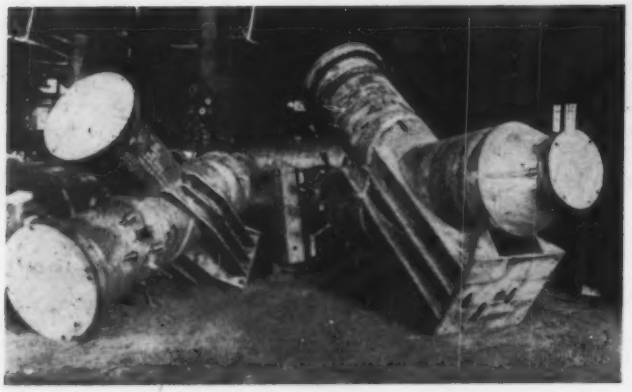
TUBE TURNS, INC., LOUISVILLE 1, KENTUCKY

District Offices at New York, Washington, D. C., Philadelphia, Pittsburgh, Detroit, Chicago, Houston, San Francisco, Los Angeles

TUBE-TURN TRADE MARK **tt** *Welding Fittings and Flanges*

ONE SOURCE OF SUPPLY FOR ALL WELDING FITTING REQUIREMENTS

Make Your "PIPE DREAMS" Come True!



Better piping . . . built to your own special designs . . . is no dream when you turn to Lancaster. There's a solid background of engineering experience and a practical knowledge of construction requirements behind Lancaster O. D. pipe, tees, elbows, etc. Penstocks designed for quality, economy and long life are a specialty . . . as are also autoclaves for the curing and forming of molded plywood, vulcanizing, creosoting and other uses.

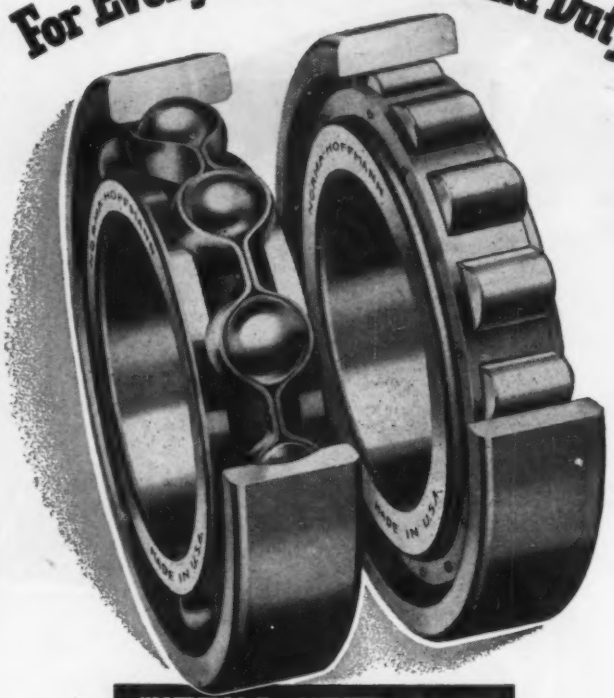
Whether it's fabricated from Class A steel, alloy steel, or wrought iron, Lancaster pipe is designed for quality, economy and long life. It's always sound practice to consult Lancaster's experienced engineers *every* time you have a problem that involves piping, tanks or any type of fabricated steel plate work. Complete designs and estimates will be submitted with no obligation to you. Write, phone or wire today.

Write now for detailed information

New York Office: Graybar Building

LANCASTER IRON WORKS, INC.
LANCASTER, PENNA., U. S. A.

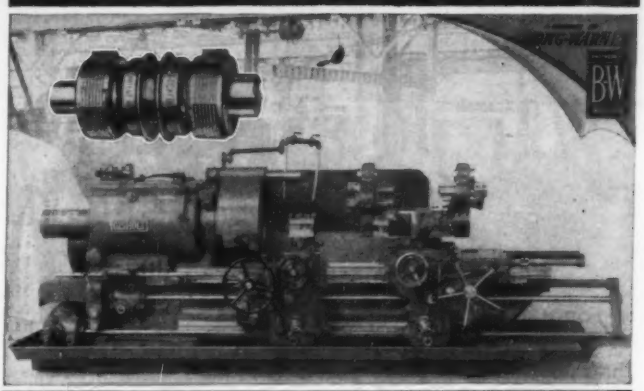
For Every Load, Speed and Duty



"NORMA-HOFFMANN"
Precision Bearings
BALL, ROLLER, THRUST—3000 SIZES

NORMA-HOFFMANN BEARINGS CORPORATION, STAMFORD, CONNECTICUT

ROCKFORD



PULLMORE MULTIPLE-DISC CLUTCHES

COMPACT DESIGN
HIGH TORQUE
HIGH-RATIO LEVERS
POSITIVE NEUTRAL
PREC'SION BUILT
LONG WEAR LIFE
EASY ADJUSTMENT

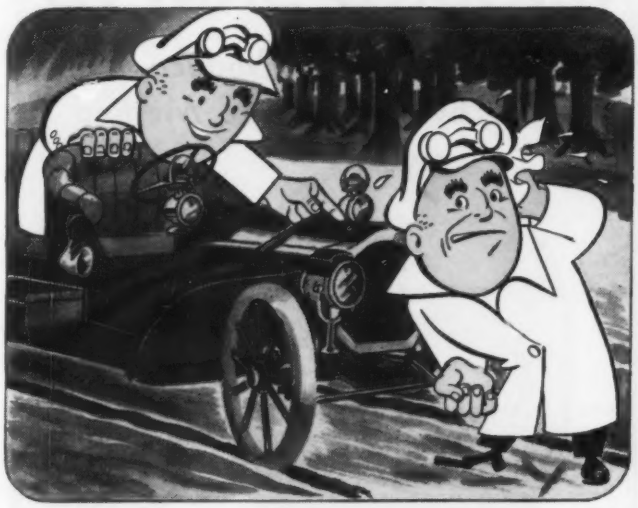
* One-point adjustment, by hand, of ROCKFORD Multiple-Disc CLUTCHES is simple, easy and ample to maintain uniform operating conditions under long, hard usage. Unaffected by centrifugal force, PULLMORE clutches are convenient to operate and are positive in driving, braking and neutral action.

SEND FOR THIS HANDY BULLETIN

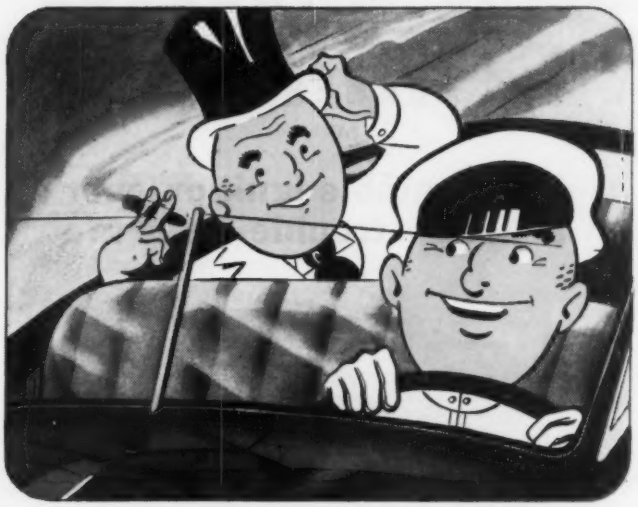
Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

ROCKFORD CLUTCH DIVISION BORG-WARNER
1307 Eighteenth Avenue, Rockford, Illinois, U. S. A.

Keeping drivers off their feet

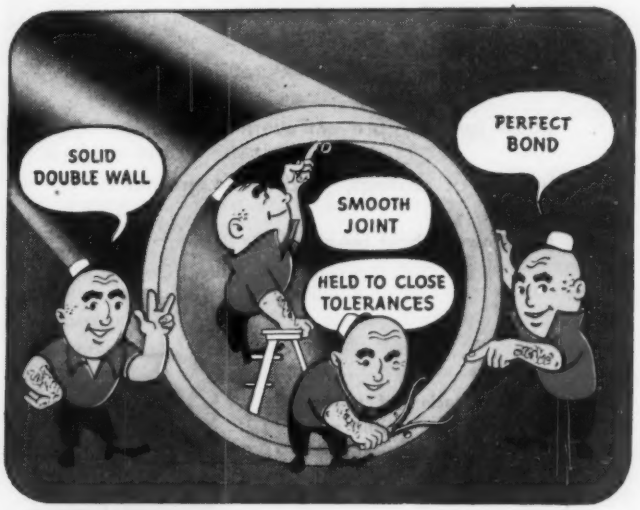


1. **NOT** too far back in automotive history, an hour's ride was an expedition. Driving took a strong arm on the wheel and a stronger one on the crank. It was never unusual to get out and get under. Mechanical breakdowns were frequent and many a rider was forced to walk.



2. **TODAY'S** cars are marvelous for dependability and riding comfort. From bumper to bumper, every part has been improved to make motor cars more economical, more efficient and easier to drive. It is startling to think how seldom the modern motor car leaves its driver stranded.

3. **EACH** motor vehicle rolling off our production lines has an average of more than twenty Bundy Tubing parts. Industry also calls on Bundyweld to carry refrigerants in cooling devices, gas in modern kitchen ranges and fluids in many kinds of beverage and food processing equipment.



4. **BUNDYWELD** is different from other tubing. A single strip of basic metal, coated with a bonding metal, is rolled continuously twice laterally into tubular form, then metallurgically bonded by intense heat—carefully controlled—to form a solid, double wall tube, held to close dimensions.

5. **IN HUNDREDS** of modern products where the need is for outstanding mechanical properties, designers and engineers have been quick to specify Bundyweld. Let Bundy Research and Engineering Departments illustrate the advantages of Bundy Tubing for YOU! Available in steel, Monel and nickel. Write: *Bundy Tubing Company, Detroit 14, Michigan.*

BUNDY TUBING

★ ★ ENGINEERED TO YOUR EXPECTATIONS ★ ★

BUNDY TUBING DISTRIBUTORS AND REPRESENTATIVES:

Pacific Metals Co., Ltd. 3100 19th St. San Francisco 10, Calif.	Standard Tube Sales Corp. 1 Admiral Ave. Maspeth, N.Y.C., N.Y.	Lapham-Hickey Co. 3333 W. 47th Place Chicago 32, Illinois	Rutan & Co. 404 Architects Bldg. Phila. 3, Pa.	Eagle Metals Co. 3628 E. Marginal Way Seattle 4, Wash.	Alloy Metal Sales Ltd. 861 Bay St. Toronto 5, Canada

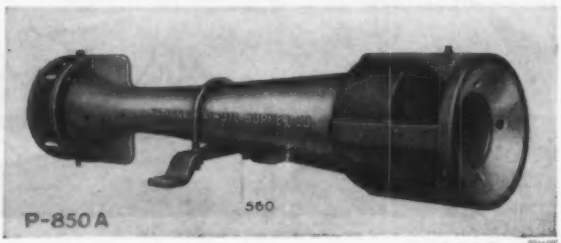
NATIONAL AIROIL BURNERS

"AIROCOOL"

GAS BURNER NOZZLES

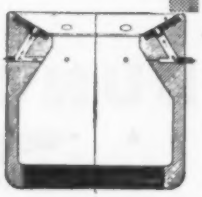
PATENTED

insure stable ignition over a long, trouble-free life



Renewable type recessed gas tips direct the separate igniter flames against the main volume of the mixture to insure stable ignition; prevent overheating and burning of castings; and allow greater turndown without burnback.

Recessed facing of refractory insulating plastic protects nozzle from extreme heat and prolongs nozzle life.



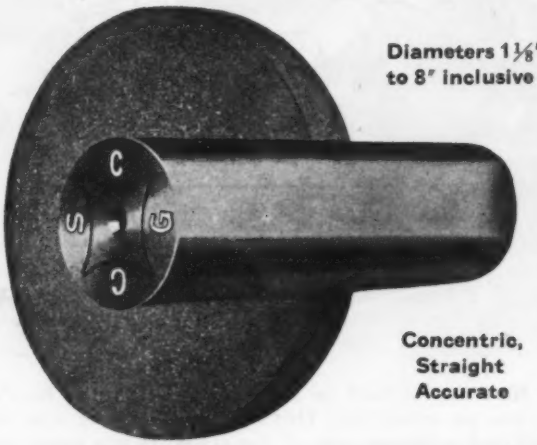
For detailed information about these long-life nozzles, write for Supplement 3 to Bulletin 55.

NATIONAL AIROIL BURNER CO., INC.

Main Offices & Factory: 1239 EAST SEDGLEY AVENUE, PHILADELPHIA 34, PA.
Texas Office: 2nd National Bank Bldg., Houston

CUMBERLAND GROUND SHAFTS

An Exclusive Product Made by an Exclusive Method



Diameters 1⅛" to 8" inclusive

Concentric, Straight Accurate

MINIMUM ELASTIC LIMIT	MAXIMUM LENGTHS MANUFACTURED
Cumberland Brand—30,000 lb. per sq. in.	Year 1845—up to 16 ft.
Potomac Brand—45,000 lb. per sq. in.	Year 1886—up to 25 ft.
Cumseo Brand—55,000 lb. per sq. in.	Year 1945—up to 70 ft.

They are carefully ground to our standard manufacturing tolerance, plus nothing to minus .002" on diameters 1-1/8" to 2-7/16" inclusive . . . plus nothing to minus .003" on diameters 2-1/2" to 8" inclusive. Closer tolerance can be furnished, if desired.

IMMEDIATE SHAFTS

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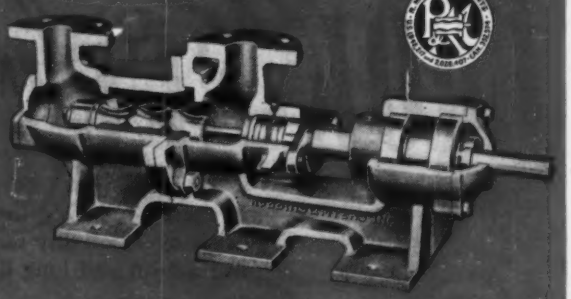
CUMBERLAND STEEL COMPANY
CUMBERLAND, MARYLAND, U.S.A.
ESTABLISHED 1845 INCORPORATED 1892

HOW DO MOYNO PUMPS WORK?

Stator, cut away to show internal form, with rotor and driving connecting rod.



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THE STATOR

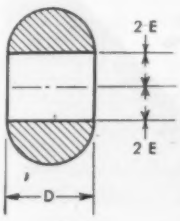

FIG. 1

A rotor-stator pumping element (above) does *all* the work; takes *all* the wear. So let us first consider the parts individually, and then put them together. For purposes of explanation, assume a forming tool made of two semi-circular discs with a rectangular section between (Fig. 1), and then assume that this forming tool (used like a hot branding iron) is *revolved uniformly* as it is pressed through a block of ice. The double-thread helical opening thus generated (Fig. 2) is our stator.

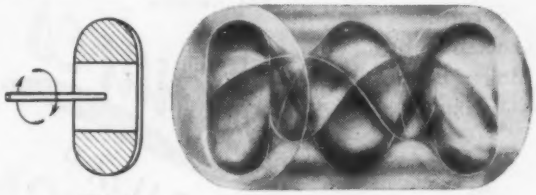

FIG. 2

Next, consider the "branding iron" as reduced to a simple disc of "D" diameter, mounted on a shaft of "E" eccentricity (Fig. 3). If this shaft were held at "E" distance *above* the axis of our stator and revolved as was the "branding iron," but with only *one-half* the lateral travel, it would feed through all of the *upper cavities* which the double-ended "branding iron" has formed.

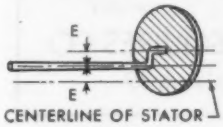

FIG. 3

THE ROTOR

Thus, if a solid rotor were made to conform with the path of this disc, it would fit into the upper portion of the stator, and leave the *lower cavities* void. Every section of such a rotor taken at right angles to its axis would be a true "D"-diameter circle, offset from the rotor axis by eccentricity "E" (Fig. 4).

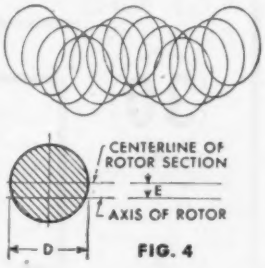

FIG. 4

In actual pump operation, the rotor executes a *compound* movement. (1) It is revolved about its axis while (2) contact between the rotor and stator causes the rotor axis to travel in a *circular path* of fixed radius "E." Total rotor "throw" thus amounts to 2E—exactly the eccentricity of our "branding iron" (Fig. 1)—so that, in each complete circuit, the rotor contacts the *entire* inner surface of the stator.

CONTINUOUS SEALING AND PRESSURE

A section through a stator with the rotor in place is shown by Fig. 5. Obviously, the only way the rotor-section can move is *up and down*. This is exactly what it does, and it is this reversing straight-line movement—this *continuous* "*wedging*"—that gives Moyno its positive pressure and uniform discharge. The rotor makes two complete revolutions while passing once around within the stator so that the hypocycloid described by the centerpoint of the rotor is a *straight line*.

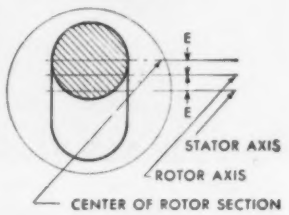

FIG. 5

Every section through the stator must contain an opening corresponding to Fig. 1—but in varying positions of rotational angularity, depending upon *where* the section is taken. Every rotor-section, therefore, travels back and forth, as just described, creating *continuous* spiraling seal lines while forcing material through the stator and automatically recreating voids at the intake end.

SWEEPING ACTION AT SEALS

The revolving rotor turns in the direction *opposite* to that of rolling rotation at the seal lines. This tends to sweep particles *away* from the seals, but should they become imbedded in the stator, the rotor will pass over them, and following pockets of fluid will flush them free.

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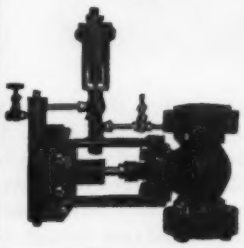

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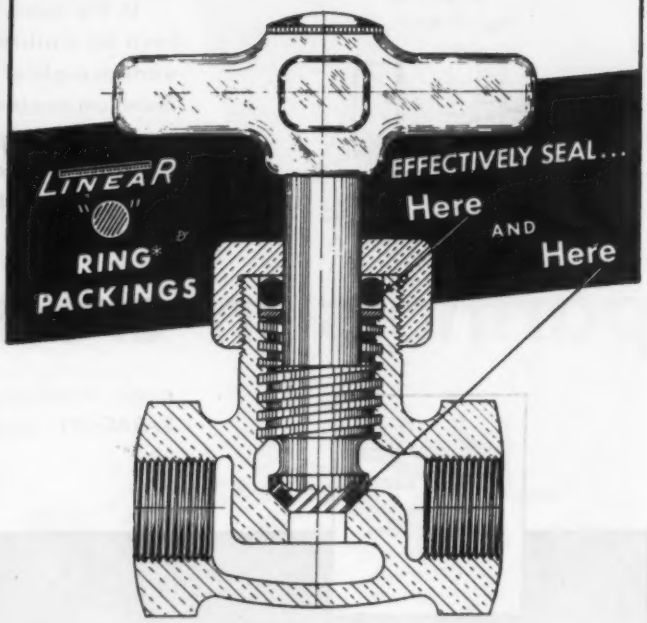

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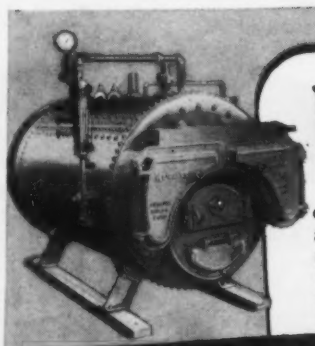

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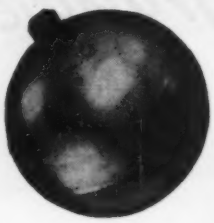

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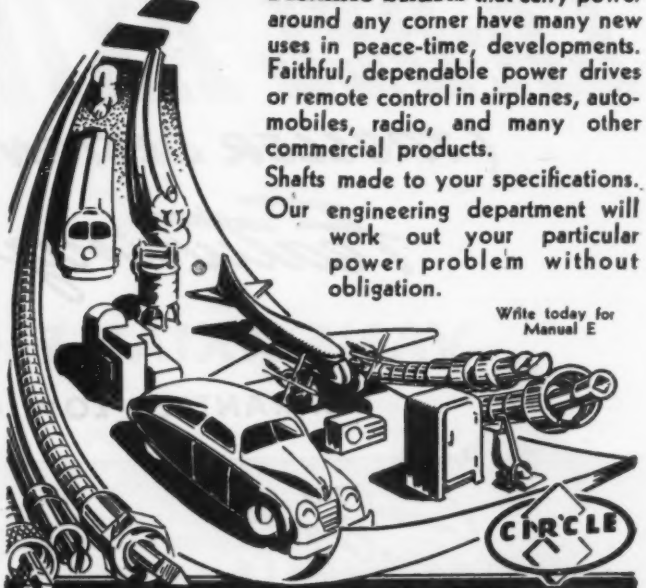

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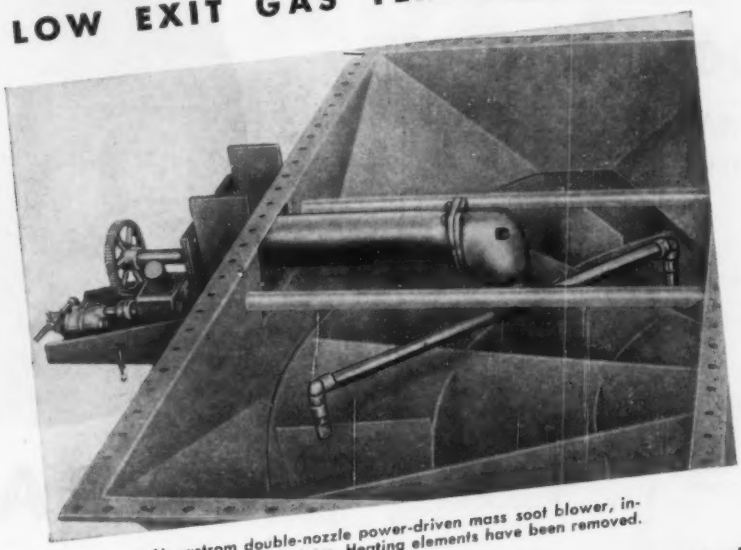

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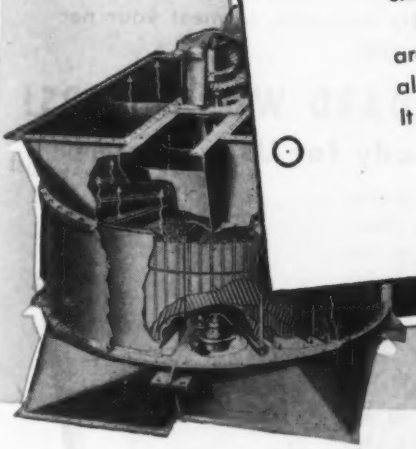

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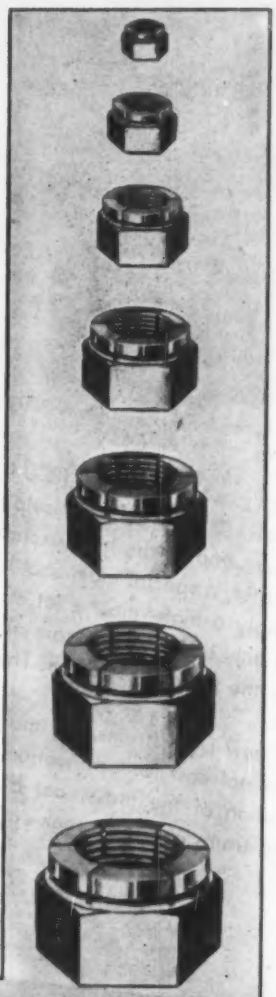

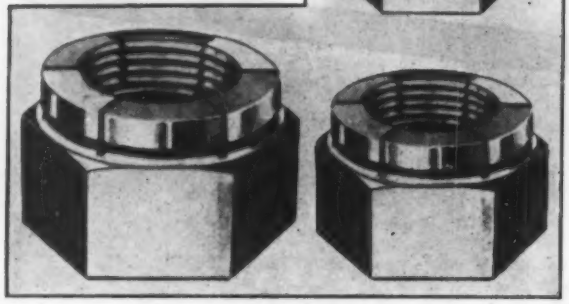

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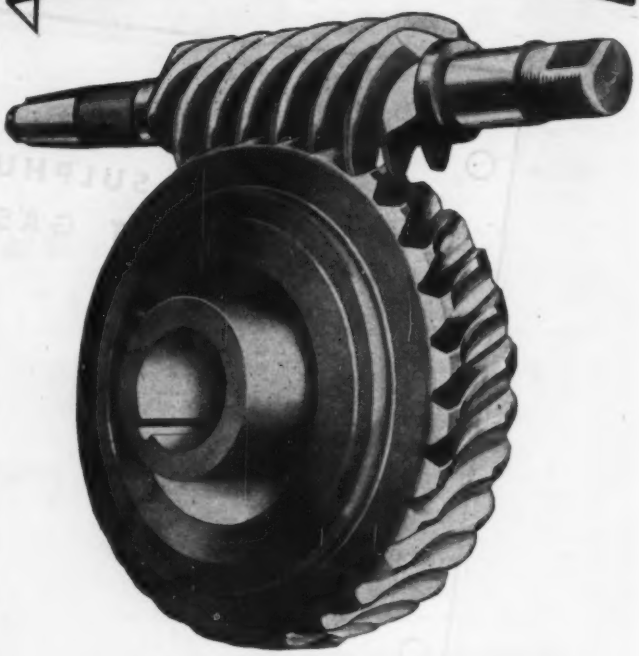

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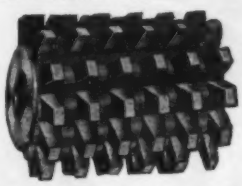

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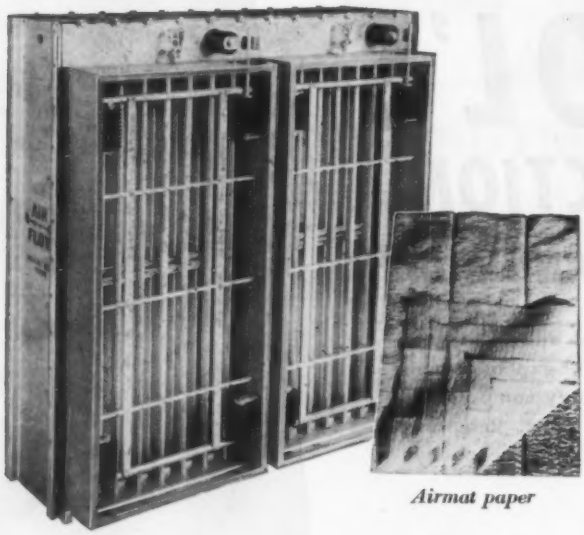

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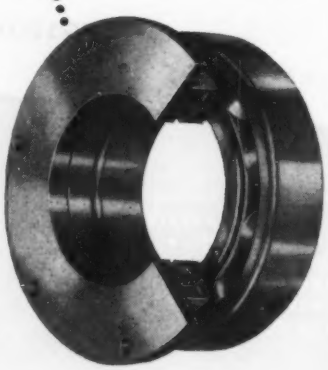

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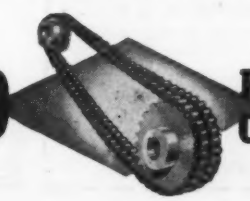
DIAMOND  **ROLLER CHAINS**

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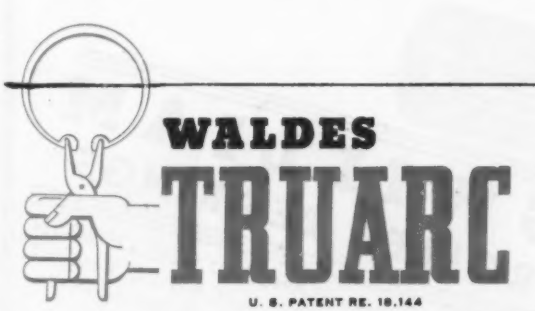

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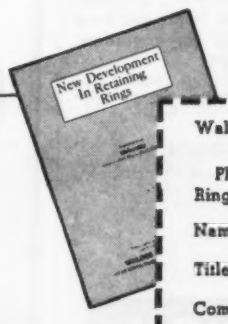

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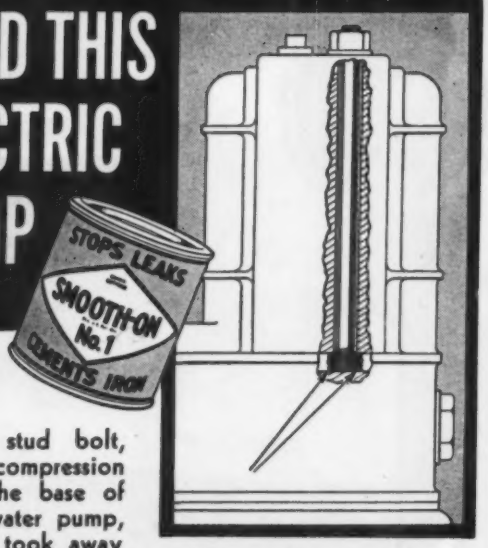

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MECHANICAL ENGINEERING
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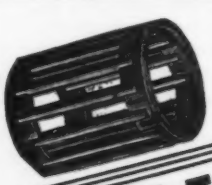

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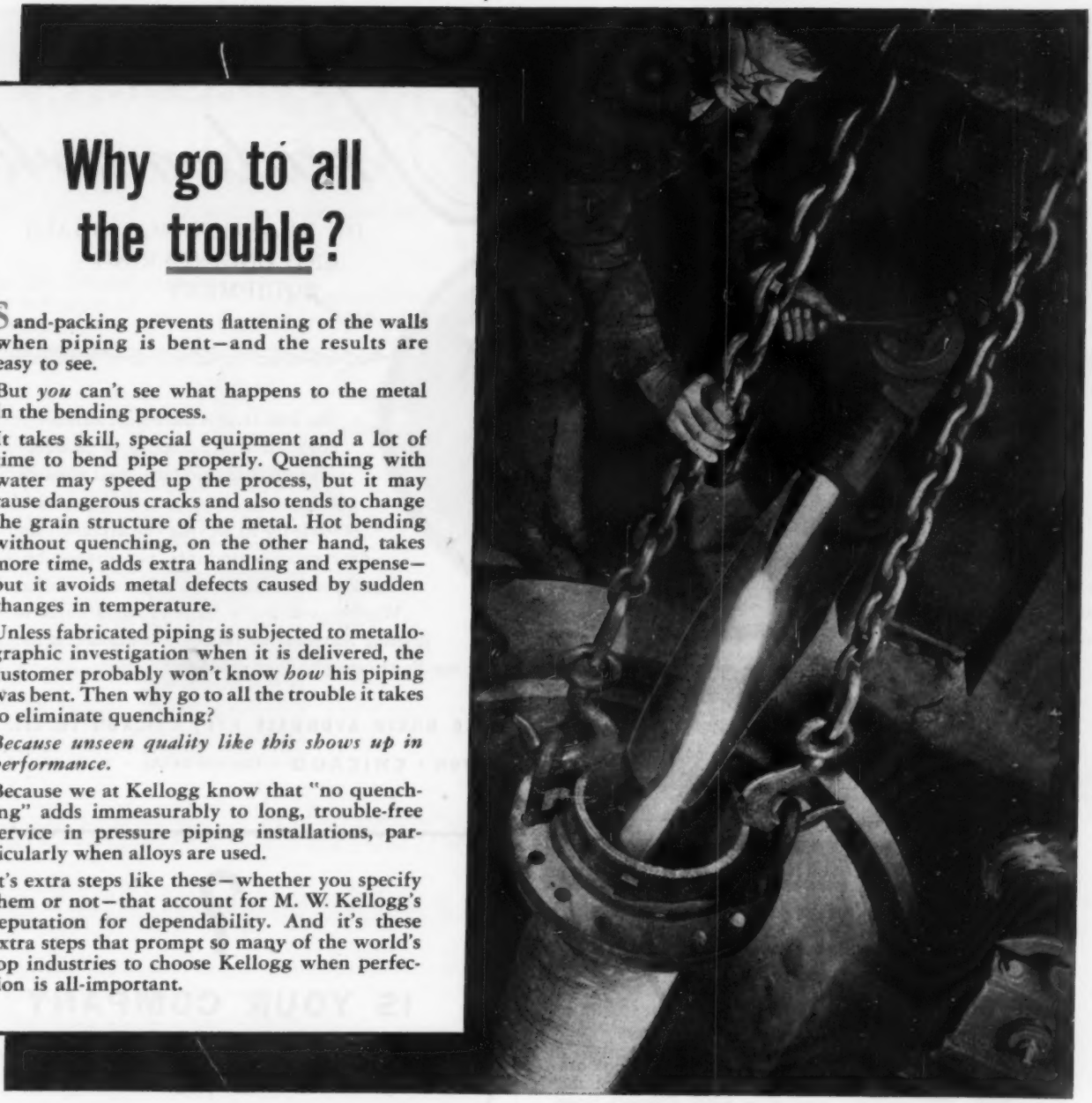

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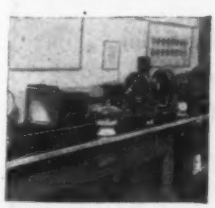

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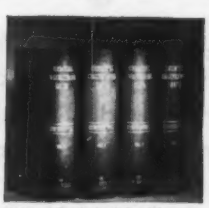

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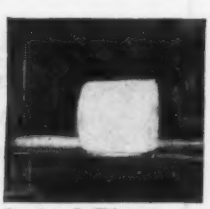

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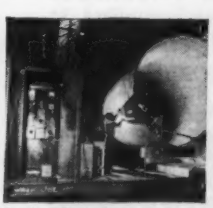

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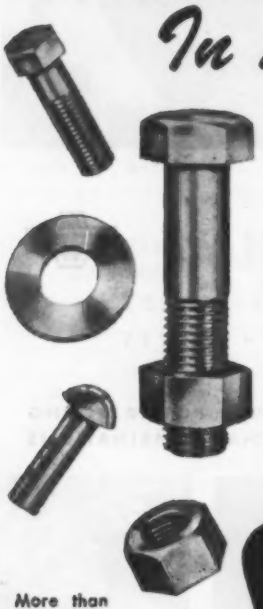

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STANDARD ENGINEERS NOTEBOOK

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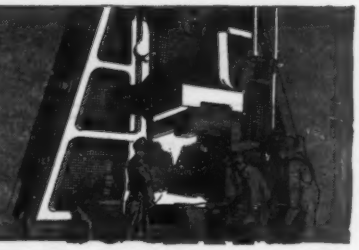

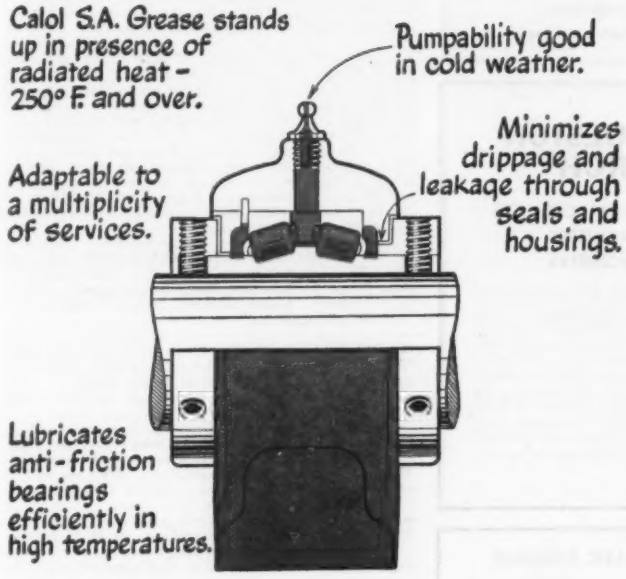
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Pumpability good in cold weather.
Minimizes drippage and leakage through seals and housings.
Adaptable to a multiplicity of services.
Lubricates anti-friction bearings efficiently in high temperatures.

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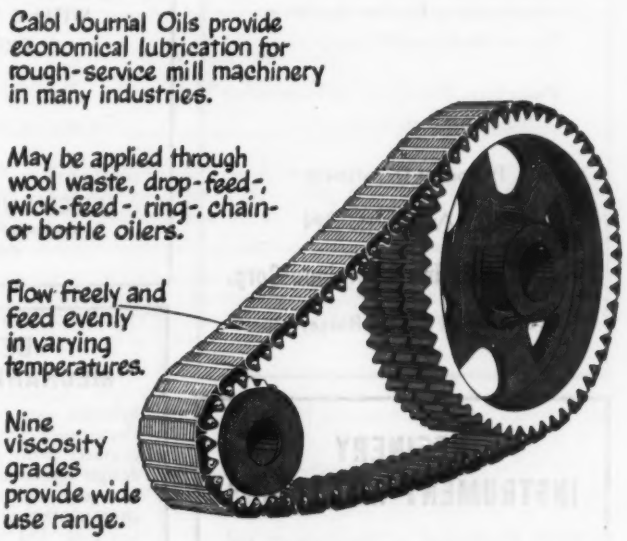
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Nine viscosity grades provide wide use range.

Chain Drive

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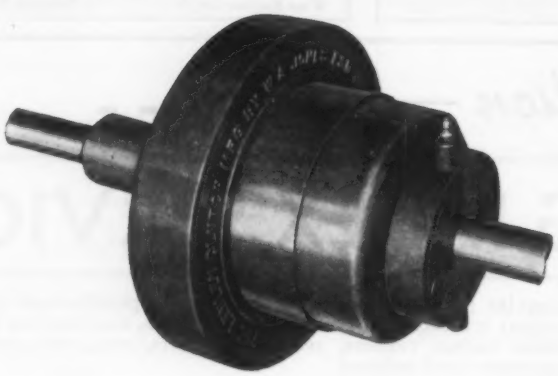

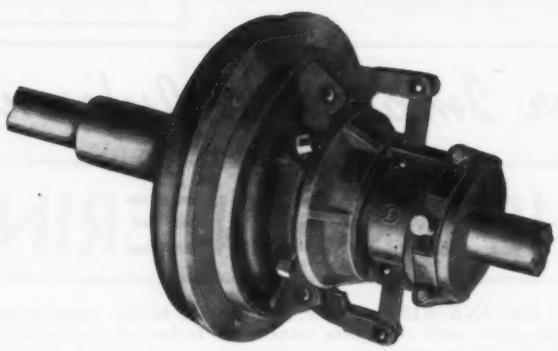

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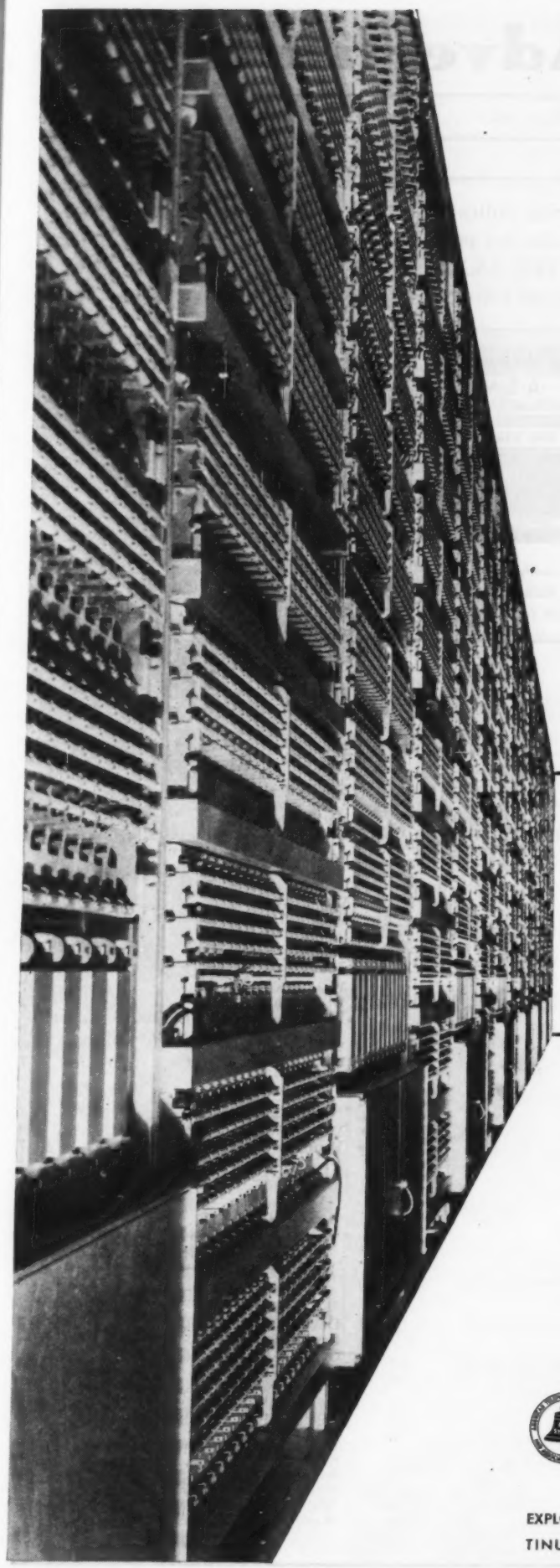

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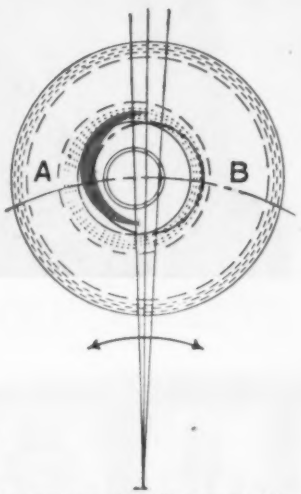

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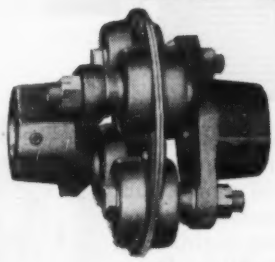

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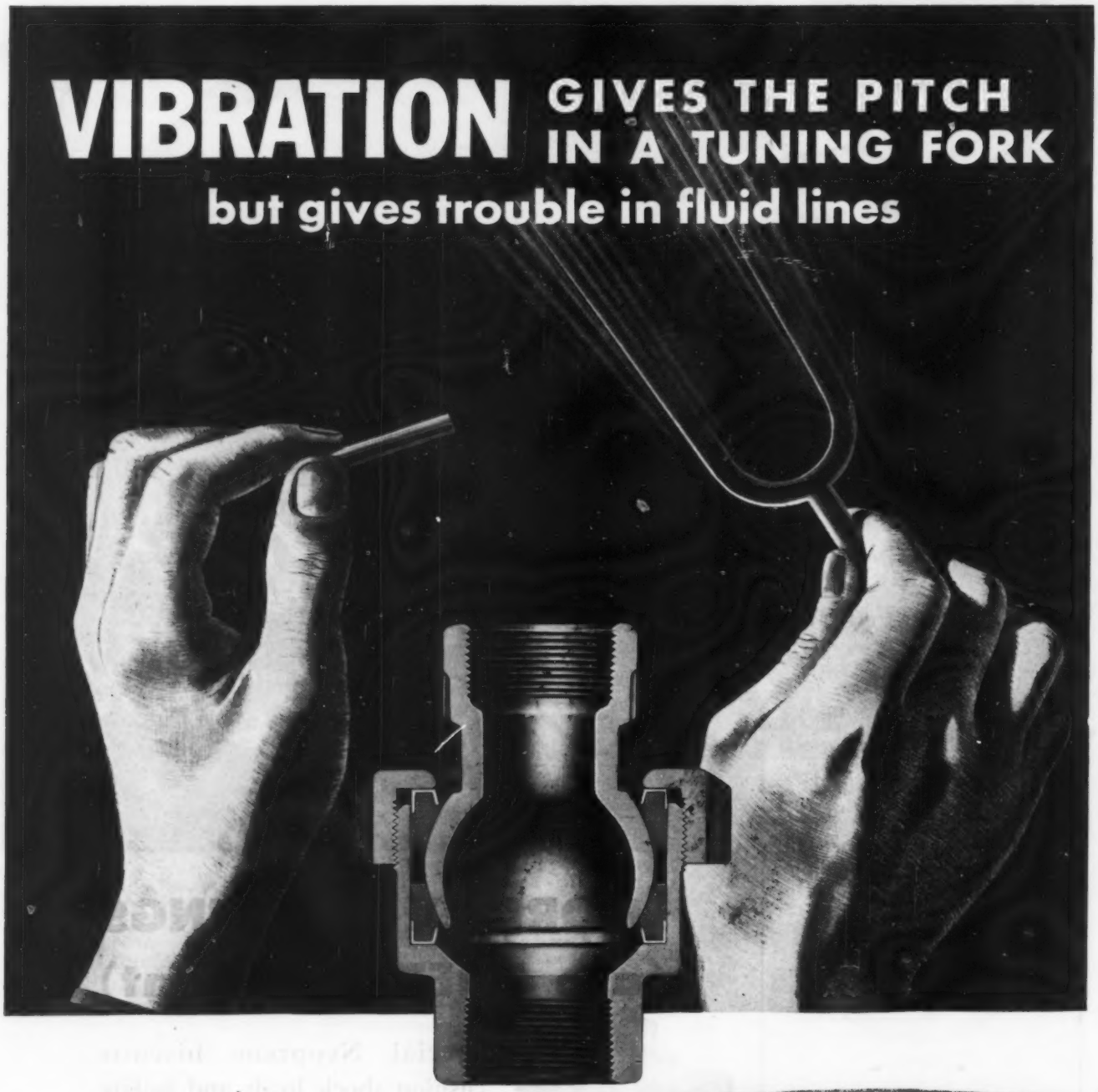

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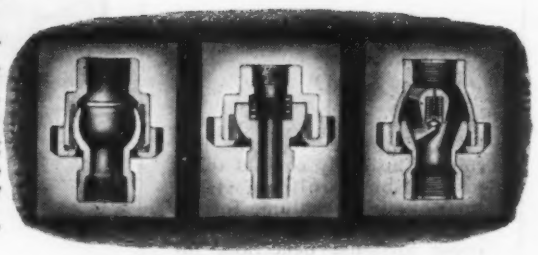

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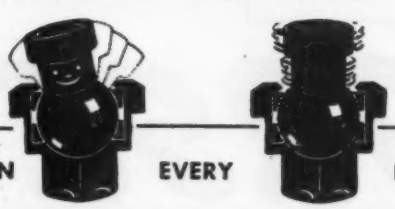

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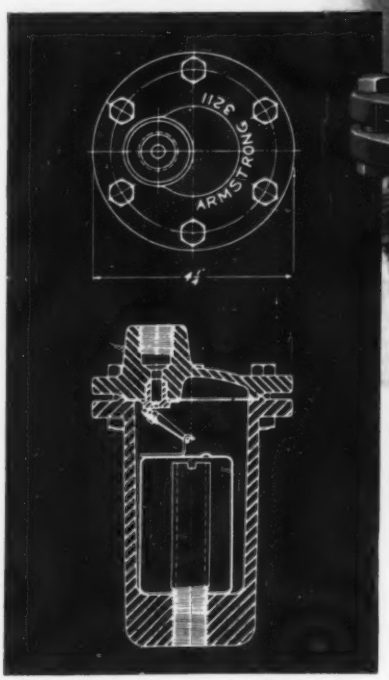

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